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DOE Contract No. DE-AC05-98OR22700
Job No. 23900
August 31, 2001

Mr. W. Don Seaborg
Paducah Site Manager
U.S. Department of Energy
P.O. Box 1410
Paducah, KY 42002-1410

Subject: Transmittal of *90% Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1921&D1/R1); *Treatability Study Work Plan for Six-Phase Heating Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1889&D2); *and Construction Qualify Control Plan for the Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1944&D2)

Dear Mr. Seaborg:

At the direction of the Department of Energy (DOE), 13 copies of each of the subject documents are enclosed for distribution to the regulatory agencies by August 31, 2001. Seven copies of each are to be transmitted to the following at the state regulatory agencies: Ms. Gaye Brewer, Mr. Steve Hampson, Mr. Tuss Taylor (three), Mr. John Volpe, and Mr. Mike Welch. Three copies of each are to be transmitted to Mr. Carl Froede of the U.S. Environmental Protection Agency, and three copies of each are for your use. These documents are being distributed in accordance with the *Standard Distribution List for Bechtel Jacobs Company LLC Primary and Secondary Documents (04/10/01)*. Suggested text is also enclosed for your use in distributing these documents.

In order to meet a Federal Facility Agreement milestone for the field-start of the treatability study on November 5, 2001, the documents are under a 14-day review period. Please request that the regulatory agencies provide comments, if necessary, and approve the D2 documents by Friday, September 14, 2001. Any comments on the 90 percent design document will be addressed and incorporated into the *Certified for Construction Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1921&D2).

It is a pleasure assisting DOE on this project. If you have any questions or need additional information, please contact Mark Gage of my staff at 5125.

Sincerely,

Gordon L. Dover
Paducah Manager of Projects

GLD:ll
LTR-PAD/EP-LL-01-0094

Enclosures: 1. Suggested text
2. Subject documents (13 copies of each)

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Secondary Document

Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant, Paducah, Kentucky

I-04611-0137

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Secondary Document

Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit, at Paducah Gaseous Diffusion Plant Paducah, Kentucky

Date Issued—August 2001

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-98OR22700

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CONTENTS

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CONTENTS (continued)

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FIGURES

TABLES

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ABBREVIATIONS AND ACRONYMS

AST	aboveground storage tank
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
EDD	electronic data deliverable
Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
FFA	Federal Facility Agreement
FS	feasibility study
GAC	granular activated carbon
GWOU	Groundwater Operable Unit
Kv	kilovolt
kW	kilowatt
M&I	management and integration
OREIS	Oak Ridge Environmental Information System
PCU	power control unit
PEMS	Project Environmental Measurements System
PID	photoionization detector
PGDP	Paducah Gaseous Diffusion Plant
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
RAAS	Remedial Action Assessment Subcontract
RGA	Regional Gravel Aquifer
RI	remedial investigation
SAIC	Science Applications International Corporation
SOW	statement of work
SPH	Six-Phase Heating
STR	Subcontract Technical Representative
^{99}Tc	technetium-99
TCE	trichloroethene
TSWP	treatability study work plan
TWA	time-weighted average
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
VR	vapor recovery
WAG	Waste area grouping
WMP	Waste Management Plan

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EXECUTIVE SUMMARY

The Six-Phase Heating (SPH) treatability study will be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This preliminary record of decision study will provide quantitative treatment data and cost data to assess the feasibility of deploying this technology as a part of the remedial action for the Groundwater Operable Unit (GWOU). The study will be consistent with the *Federal Facility Agreement* among the U.S. Department of Energy, the U.S. Environmental Protection Agency (EPA) and the Commonwealth of Kentucky (EPA **1998).** The SPH treatability study follows the guidance set forth in the EPA's *Guide for Conducting Treatability Studies under CERCLA* (EPA **1992).**

The primary objective of the SPH treatability study is to demonstrate the implementability of the SPH technology in the unsaturated and saturated zones of the Upper Continental Recharge System (UCRS) and in the underlying Regional Gravel Aquifer (RGA). A successful implementation will demonstrate that SPH can cost effectively heat soil and groundwater in both the UCRS and RGA, can recover steam and the target contaminant vapors (trichloroethene in this case), and can treat the recovered contaminant vapors.

The planned treatability study will include the design, installation, and operation of one SPH array. A single SPH array consists of six power electrodes, a center neutral electrode, an electrical power control unit, a steam and contaminant vapor recovery (VR) system, temperature and pressure monitoring systems, and contaminant vapor and water treatment systems. The SPH system operates by applying electricity to electrodes that have been placed at specified depths in the subsurface. As power is applied to the electrodes, the soil matrix resists the flow of electricity among the electrodes causing the subsurface to be heated. Subsurface temperatures are increased to the boiling point of groundwater and targeted contaminants are volatilized. Steam and volatilized contaminants migrate upward and are collected in the vadose zone by VR wells. Steam then is condensed to water and contaminant vapors are processed by the vapor treatment system. Electrodes will be installed to a total depth of 30 m **(97** ft) below ground surface, which is slightly below the base of the RGA. The planned SPH treatability study will allow treatment of both the shallow UCRS and the underlying RGA and is intended to test the constructability, remedial effectiveness, and cost effectiveness of deploying the technology in the area adjacent to the C-400 Building.

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1. PROJECT DESCRIPTION

In August 1988, volatile organic compounds (VOCs) and radionuclides were detected in residential wells near the **U.S.** Department of Energy's (DOE's) Paducah Gaseous Diffusion Plant (PGDP). Between 1988 and the present, numerous groundwater investigations have been conducted to identify probable source areas. To address these source areas, the D2 version of the Groundwater Operable Unit (GWOU) Feasibility Study (FS) was issued August 2001 (DOE 2001a). As part of this FS, it is necessary to understand the effectiveness of certain treatment technologies that are being considered for full-scale use (based on applicability to specific site conditions). This Treatability Study Work Plan (TSWP) is for a treatability study using Six-Phase Heating (SPH) at the C-400 Building.

The SPH treatability study at the C-400 Building will be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and will follow the guidance set forth in the **U.S.** Environmental Protection Agency's (EPA's) ***Guide for Conducting Treatability Studies under CERCLA*** (EPA 1992). The study will be consistent with the ***Federal Facility Agreement*** (FFA) among the DOE, EPA, and the Commonwealth of Kentucky (EPA 1998). This preliminary record of decision study will provide quantitative treatment effectiveness and technology cost data for evaluating the constructability, applicability, and performance of the **SPH** technology in remediating trichloroethene (TCE) source areas at PGDP.

1.1 GEOLOGY AND HYDROGEOLOGY

The depths to various lithologic units vary across the C-400 Building region. The depths presented in this design are approximate and actual depths will be determined or verified as the first new borings are installed. Similarly, the depths to groundwater vary considerably with season; however, consistent depths are used in this design for ease of understanding. All depths have been rounded to the nearest meter and nearest foot.

The PGDP overlies the southern extent of the ancestral Tennessee River. A 11-m (35-ft) thick sand and gravel deposit of the ancestral Tennessee River extends from beneath the PGDP northward **to** the Ohio River. These coarse sediments form the shallow aquifer beneath the PGDP, known as the Regional Gravel Aquifer (RGA). Immediately underlying the RGA is the Upper Cretaceous McNairy Formation. The upper portion of the McNairy Formation consists of interbedded silts, sands, and clay. The middle member, the Levings member, generally is a silty clay, while the lower McNairy Formation primarily is sand with some silts and clays.

The treatability study will be conducted near the southeast corner of the C-400 Building, and the lithology at this location is extremely variable. The main hydrogeologic units beneath the treatability study area consist of the Upper Continental Recharge System (UCRS), the RGA, and the McNairy Formation. In the study area, the RGA and the first major sand of the upper McNairy Formation are separated by an approximately 3- m (9-ft) thick lens of McNairy silts, sands, and clays, which act as an aquitard. Approximately 17 m (56 ft) of silt and clay, with horizons of sand and gravel lenses, covers the RGA. The groundwater flow system developed in these shallow sediments is called the UCRS. Groundwater typically is encountered in the UCRS at approximately 12 m (39 ft) below ground surface (bgs). The RGA potentiometric surface is encountered at a depth of approximately 17 m (56 ft) bgs. The RGA is saturated throughout and recharged primarily by vertical groundwater flow from the UCRS. Hydraulic gradients direct groundwater flow in the RGA laterally to the north where groundwater discharges into the Ohio River.

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1.2 LOCATION OF TREATABILITY STUDY

Previous site investigations have identified three groundwater contaminant plumes resulting from past activities at PGDP. All three of the plumes are located in the RGA. Two of these plumes, currently identified as the Northwest Plume and Northeast Plume, receive considerable contaminant loading from the C-400 Building area. Fig. 1.1 shows the relationship between the maximum concentrations (greater than 100,000 μg/L) of TCE contamination and the C-400 area.

The Waste Area Grouping (WAG) **6** Remedial Investigation (RI) (DOE 1999) characterized the nature and extent of contamination around the C-400 Building. The WAG ***6*** RI concluded that there are zones of TCE dense nonaqueous-phase liquid (DNAPL) in the UCRS and RGA beneath the C-400 Building. Appendix E of this SPH treatability study, taken from the GWOU **FS** (DOE 2001a), presents a summary of the characterization data for the C-400 area DNAPL zones and documents the area DNAPL conceptual models. The data are sufficient to suggest that the southeast C-400 DNAPL zones account for the majority of **mass** of residual and pooled DNAPL. Given the high concentrations of TCE in the RGA groundwater, it is assumed that DNAPL has migrated to the RGA. **As** part of the WAG ***6*** RI, the UCRS soil was characterized and shown to be a residual source of DNAPL. Accordingly, the **SPH** treatability study is centered on the area with highest **UCRS** soil contamination levels and with high TCE levels in RGA groundwater (and possible DNAPL accumulation). This location is boring 400-200 (plant coordinates -4081 east, -1725 north), with the TCE concentration of 11,055 mg/kg. To encompass boring 400-200, the SPH array will be located near the southeast corner of the C-400 Building as shown in Fig. 1.2.

1.3 SIX-PHASE HEATING TREATABILITY STUDY DESCRIPTION

The SPH system operates by applying electricity to electrodes that have been placed at selected depths in the subsurface. As power is applied to the electrodes, the soil matrix becomes an electrical resistance heater, raising the temperature of the soil to a level so that the target contaminants (TCE in this case) are volatilized. Both contaminants and steam are removed using vapor recovery (VR) wells. Detailed information on SPH and its operation is provided in Sect. 2 and in the ***90% Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (SPH Design Package) (DOE 2001b).

The planned treatability study will include the design, installation, and operation of one SPH array. A single array consists of six power electrodes, a center neutral electrode, an electrical power control unit (PCU), a steam and contaminant VR system, pressure and temperature monitoring systems, and contaminant vapor and water treatment systems. The treatability study is designed **to** test the effectiveness of the SPH technology in the complex hydrogeology at the C-400 Building. Electrodes will be constructed to a final depth of **30** m **(97** ft) bgs, and each will consist of six depth-discrete electrical resistance heating intervals covering the UCRS, the RGA, and the upper interbedded silt, sand, and clay layer of the McNairy Formation.

The treatability study array will be set up at the C-400 Building as described in Sect. **6.1.** Pre-test soil and groundwater samples will be collected from borings, as described in Appendix A, to document the contaminant concentrations in the vicinity of the treatability study array. **As** the electrodes heat the subsurface, volatile organics and groundwater will be converted to the vapor phase. These vapors will migrate upward to be recovered by VR wells and steam vents constructed within the electrode borings and by the steam vents located in the vacuum monitoring piezometer borings. Captured vapors and steam will be evacuated to the surface where the steam will be condensed and the vapors will be adsorbed onto granular activated carbon (GAC) filters. Treated condensate will be recycled within the aboveground systems as makeup water for the **SPH** processes and treated air will be released to the atmosphere.

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Electrical resistance heating will continue for approximately 130 days; after which time, electrical resistance heating will be shut down and the treatability cell will be allowed to return gradually to ambient temperatures. The actual period of electrical resistance heating will depend upon how rapidly the system purges the test cell of contamination. Operations monitoring, described in Sect. 8.3, will produce the data needed to determine the actual electrical resistance heating time. Upon completion of the test, the effectiveness of the system will be verified by installing new borings adjacent to selected pre-test borings, as described in Appendix **A.** Soil samples will be collected from these new borings and analyzed, and the data will be compared to the pre-test data. Post-test groundwater samples will be collected from the multi-port monitoring wells, and the data will be compared to the pre-test data.

A total of 35 borings is planned for the project: 4 borings are multi-level groundwater and soil temperature monitoring wells; 7 borings are electrode and VR wells; 15 are vacuum monitoring piezometers and backup VR points; and 9 are post-test assessment borings.

1.4 STAKEHOLDER/REGULATORY APPROACH

1.4.1 Current Status

Remedial activities at the PGDP are conducted under an FFA among DOE, EPA, and Commonwealth of Kentucky (EPA 1998). This treatability study will be conducted under CERCLA and follows the guidance set forth in the EPA's ***Guide for Conducting Treatability Studies under CERCLA*** (EPA 1992).

1.4.2 Regulatory Requirements and Notifications

All activities to be conducted during the treatability study will comply with the substantive requirements of all federal and Commonwealth of Kentucky laws and regulations.

Section 1.3.2 of the SPH Design Package (DOE 2001b) describes some of the activities covered by various PGDP work permits.

2. TREATMENT TECHNOLOGY DESCRIPTION

The following sections provide greater detail of the design and operation of the SPH system. Full details, including engineering drawings, are located in the SPH Design Package (DOE 2001b).

2.1 SIX-PHASE HEATING

SPH systems have been demonstrated to effectively remove volatile and semivolatile contaminants from soils and groundwater (EPA 1999). To implement the technology, an array of six power electrodes is placed in the ground so that the electrodes surround the targeted contaminated region. Each electrode is connected to a separate power supply transformer to provide it with a unique phase of electrical current. The electrode spacing and the connected electrical phases are both ***60"*** apart, producing a uniform ratio of voltage difference to the physical distance between electrodes. A typical SPH array is hexagonal in shape, with a neutral electrode located at the center.

When electrical power is delivered, current is conducted through the soil moisture, which heats the soil resistively. This heating volatilizes contaminants and water (producing steam) in the soil, effectively steam stripping VOC contaminants ***in situ***. The volatilized contaminants and steam then are removed by VR wells and treated aboveground. For this treatability study, the captured vapors and steam will be evacuated to the surface where the steam is condensed and the vapors will be adsorbed onto **GAC** filters. Treated condensate will be recycled within the aboveground systems as makeup water for the SPH processes, and treated air will be released to the atmosphere. This process results in accelerated removal of target contaminants from soil and groundwater compared to conventional soil-vapor extraction and does not require major excavation.

The only additive that may be required for SPH is potable water, which normally is added to the vadose-zone soil surrounding the electrodes during operation. This prevents the soil adjacent to the electrodes from drying out and becoming nonconductive. However, some aquifers contain sufficient moisture to keep the electrodes conductive throughout the operation.

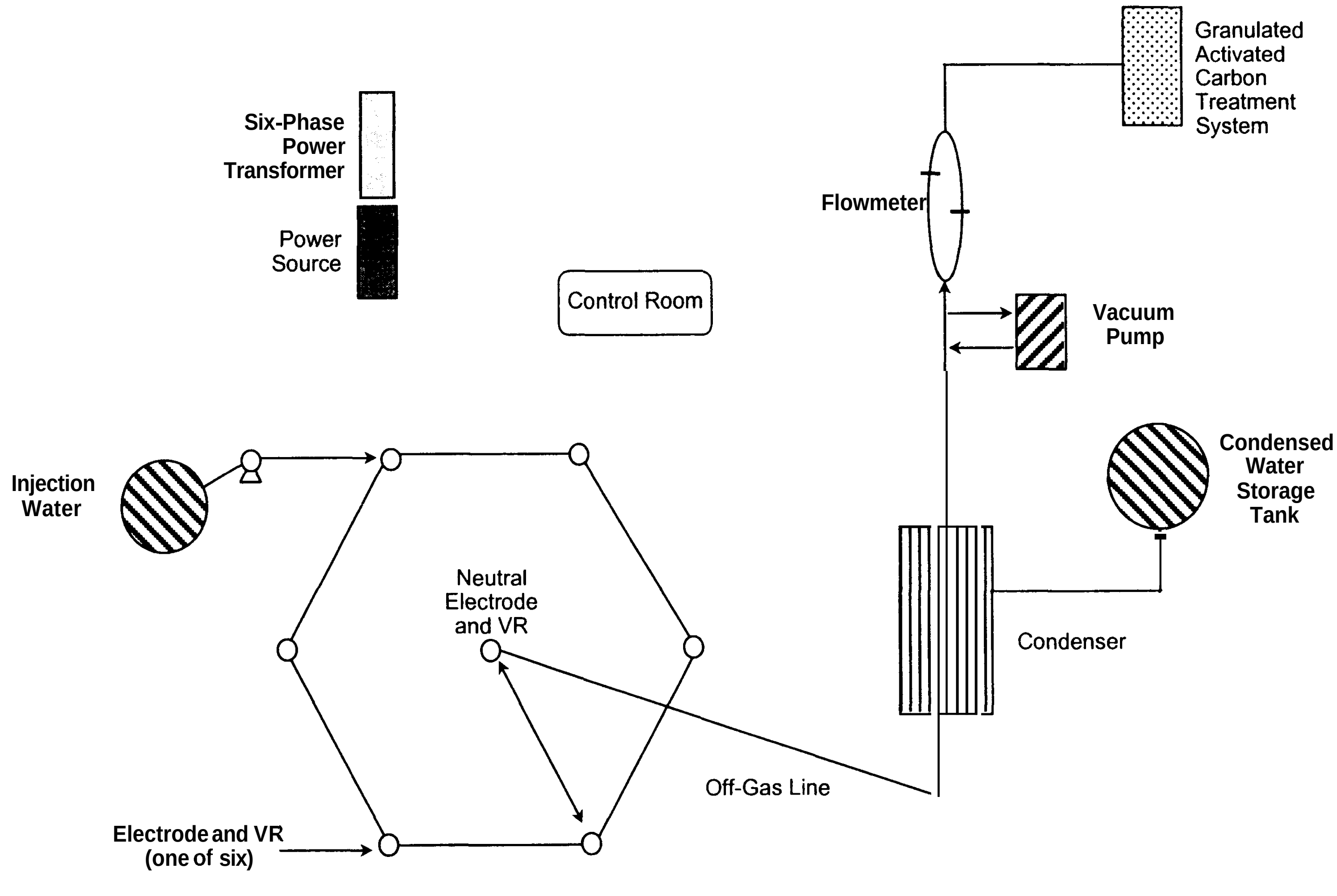
The components required to implement SPH are electrodes; VR wells; a steam and vapor collection system (including piping, a blower, **a** condenser, and a condensed water storage tank); a vapor treatment system; an electrical PCU used to condition power for application to the soil; and a computer control/data acquisition system for continuous remote control of power. **A** schematic of the system is presented in **Fig. 2.1.**

The volatile contaminants are collected and processed in a steam and vapor collection system. **As** the soil and groundwater is cleaned, contaminant concentrations in the steam and vapor decrease. In a remedial cleanup, when the steam and vapor concentrations decrease to and remain at an agreed level, the heating is stopped. Post-remedial characterization may be conducted to determine if the cleanup objectives were achieved. For this treatability study, the planned operational period is 130 days. Post-test characterization of soils and groundwater will be performed at the completion of the operational period.

SPH is implemented in arrays of six electrodes arranged in a hexagonal pattern around a central neutral electrode. ***An*** array can be as large as 14 m (45 ft) in diameter, effectively heating a 19 m (63 ft)-diameter region of soil. To treat large volumes of soil, several arrays are operated simultaneously or the heated region can extend to a great depth [up to 61 m (200 ft) bgs]. The maximum volume of soil treated is governed by the power delivery capability of the SPH transformer [i.e., 10,000 m^3 (12,000 yd^3) of soil can be treated with a 1250 kW power supply]. For this treatability study, the SPH array will be 9 m (30 ft) in diameter, effectively heating a subsurface region measuring 13 m (42 ft) in diameter. **To** treat larger areas, several arrays are constructed side by side and operated simultaneously. The vertical limits for SPH are set by the depth to which boreholes for electrode construction can be drilled. For the PGDP, the SPH system is expected to treat approximately **3,900** m^3 (5,000 yd^3) of subsurface.

2.2 CURRENT STATE OF DEVELOPMENT AND MATURITY OF TECHNOLOGY

SPH has been applied at eight demonstrations and seven full-scale cleanups. The technology has been successful in removing contaminants in open areas as well as areas with obstructions (e.g., buildings or utilities). In addition, SPH has been successful in remediating a wide variety of soil types including tight silts and clay. Because **SPH** remediates soil and groundwater by passage of an electrical current, it is not hindered by low-permeability or heterogeneous soils (EPA 1999). Some of the sites where SPH technology has been successfully implemented to address VOC contamination include the Savannah River Site in South Carolina, a former dry cleaning site in western Washington, and an electronics manufacturing facility in Skokie, Illinois. **A** full summary of the sites can be found in the SPH Design Package (DOE 2001b).



Off-gas lines and injection water lines
Are located at each of the seven electrode/VR piezometers.
Not drawn to scale.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications
International Corporation
P O Box 2502
Oak Ridge, Tennessee 37031

Fig. 2.1. Conceptual process flow diagram.

2.3 APPLICABILITY TO THE PGDP SITE

The geology and contamination at the PGDP site are similar to the geology and contamination at the three sites listed above. All three sites were contaminated with chlorinated hydrocarbons, and clay and gravel are the dominant lithologies. At PGDP, silt and clay derived from loess are dominant lithologies in the shallow sediments [to a depth of approximately 17 m (56 ft)] that make up the UCRS. In addition, the SPH demonstrations at the three sites listed above showed that the technology is effective in areas difficult to remediate due to both the depth of contamination and the obstructions present (i.e., buildings and utilities), such as at the C-400 Building at the PGDP.

Moreover, the SPH demonstrations have shown the technology to be effective in semi-confined aquifer settings, similar to the uppermost aquifer at the PGDP, the RGA. The 11-m (35-ft) thick sand and gravel deposit that is the dominant unit of the RGA occurs at an average depth of 17 to 28 m (56 to 91 ft) below the C-400 area. All three of the off-site contaminant plumes that extend from the PGDP are developed in the RGA. The base of the RGA appears to be the greatest vertical extent of DNAPL migration at the PGDP. Because contaminant levels in the RGA are supported by source terms in the UCRS, the SPH technology will be tested in both the UCRS and the RGA during this treatability study.

3. TREATABILITY STUDY OBJECTIVES

3.1 PRIMARY OBJECTIVE

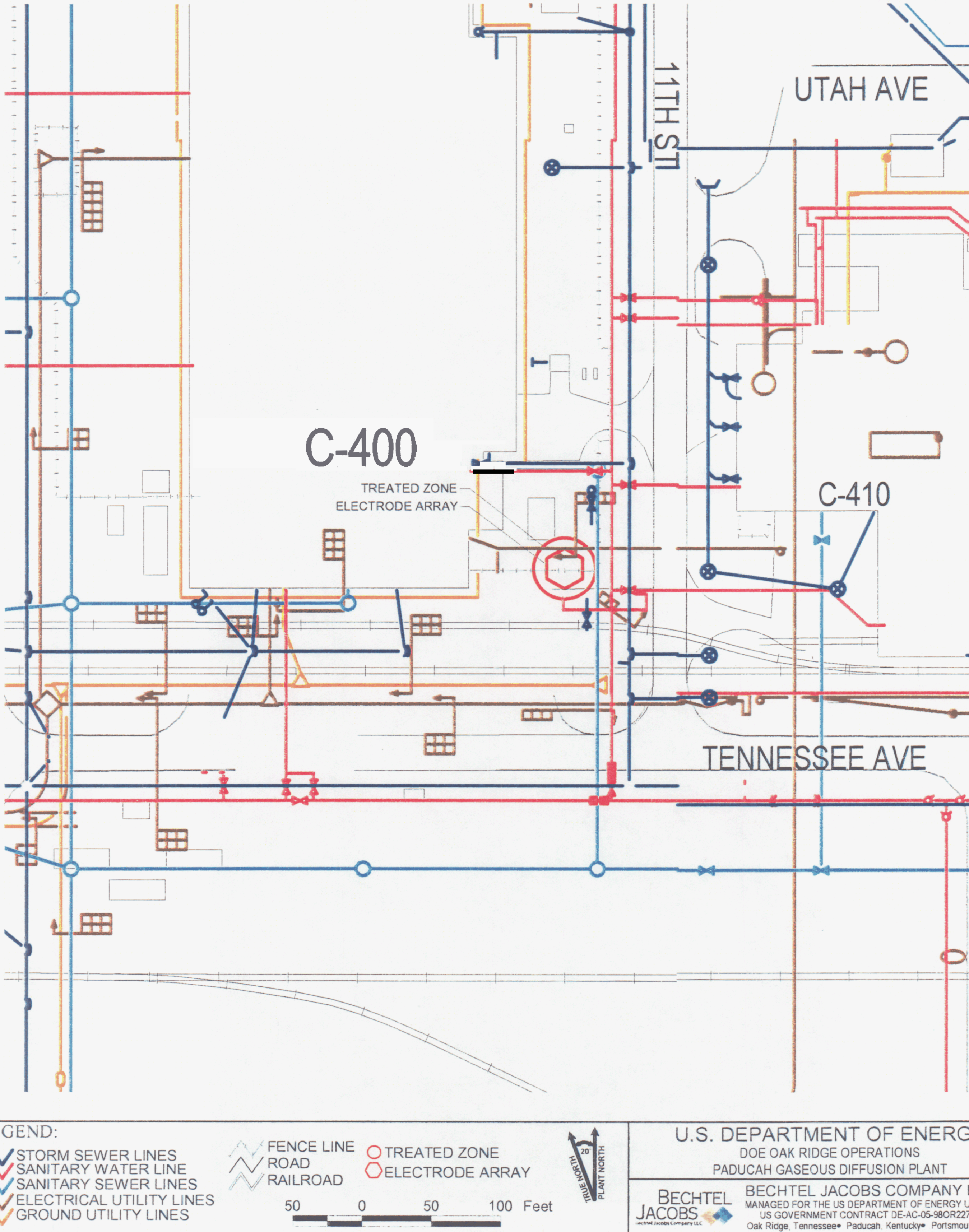
The primary objective of the treatability study is to demonstrate the implementability of this technology to the unsaturated and saturated zones of the UCRS and to the groundwater of the RGA. A successful implementation will heat the soils and groundwater in both the UCRS and RGA to a temperature that allows steam and vapors containing the TCE to rise and be moved by the VR wells, treated by the vapor treatment system, and removed from the treatability study test cell. Within this primary objective, several operational parameters will be evaluated to determine the effectiveness of the system and the impact of the SPH technology on current PGDP operations. These secondary objectives are described in Sect. 3.2.

3.2 OPERATIONAL PARAMETERS

In addition to measuring the remedial effectiveness of the SPH system, the following operational parameters will be evaluated during the treatability study for each of the three depth zones (unsaturated UCRS, saturated UCRS, and the RGA/McNairy):

- steam and temperature decay rates;
- temperature gradients throughout the test cell;
- TCE removal rates as a function of operational time and energy consumption;
- constructability of the system in the C-400 Building area;
- construction and operation costs as a function of TCE mass removed or destroyed (cost-effectiveness);
- the effect of the SPH system on adjacent utilities and facilities; and
- operational impacts experienced by United States Enrichment Corporation.

Figs. 3.1 and 3.2 show the underground utility and aboveground facility obstructions in the proposed area of the treatability study.



U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
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MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee• Paducah, Kentucky• Portsmouth, Ohio

Fig. 3.1. Underground utilities in the proposed area of the Six-Phase Heating Treatability Study.

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Oak Ridge, Tennessee 37831

FIGURE No. c5ac90001sk110.apr
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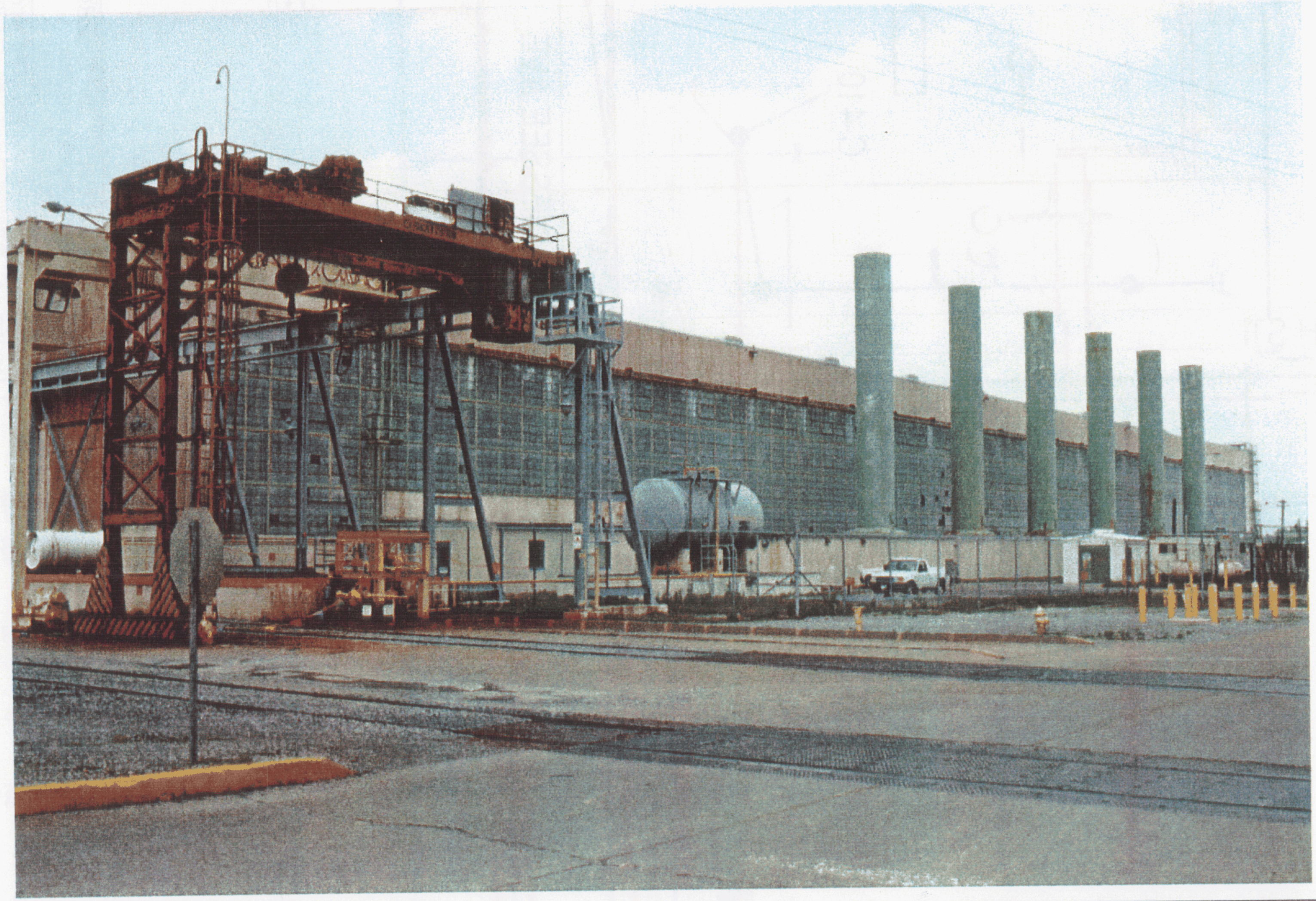

Fig. 3.2. Picture of the southeast corner of the C-400 Building looking northwest across the proposed area for the treatability study.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

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Bechtel Jacobs Company LLC

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

SAIC

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International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

FIGURE No. c400.ppt
DATE 06-01-01

4. EXPERIMENTAL DESIGN AND PROCEDURES

4.1 SCALE OF TESTING

This treatability study will provide the performance data needed to determine the feasibility of the SPH technology for treating TCE sources at the PGDP. The scale of the treatability study involves integration and performance of all the components of a full-scale, multiple array SPH system in a single array field test.

4.2 VOLUME OF MATERIAL TO BE TREATED

Appendix E of this work plan, ***Derivation of** TCE **and ^{99}Tc Source Zone Volumes for the WAG 6 Area,*** estimates that approximately 113,550 L (30,000 gal) of TCE currently are in the UCRS soils, and 570,750 L (150,000 gal) of TCE are currently in the RGA groundwater in the southeast comer outside of the C-400 Building. The treatability study SPH system to be installed will consist of a single array and will treat a small portion of the contaminated area. The depth of the SPH array will be30 m (97 ft) bgs, which is approximately 2 m **(8** ft) below the base of the RGA. The diameter of the SPH array will be 9 m (30 ft). Based upon modeling and field experience, the strong effects of heating will extend beyond that diameter by approximately 40%; thus, the actual treatment area will measure approximately 131 m^2 (1,4 14 ft'), and the approximate treatment volume will be 3,900 m^3 (5,000 yd^3).

4.3 CRITICAL PARAMETERS

Critical parameters for the SPH treatability study are those operational parameters of the system and the physical and chemical parameters of the media being treated that have the greatest impact on the ability of the technology to meet the objective stated in Sect. 3. These critical parameters for the SPH treatability study are the following.

- **Soil and Groundwater Temperature.** In order for the SPH technology to be effective, the temperature of the soil and groundwater throughout the treated volume must be raised sufficiently to drive groundwater and targeted contaminants into their vapor phases. For this treatability study, the soil and groundwater temperature must be raised to approximately 100°C at the top of the heated volume and 125°C at the bottom of the heated volume (Weast et al. 1976).

- **Treatment Time.** The treatability study is planned for 130 days, but the actual duration of the electrical resistance heating may be shortened or lengthened depending upon the rate at which the system removes TCE and water from the treated volume.

- **Soil Moisture Content.** Because heat will be conducted through the test cell by soil moisture, thorough heating of the test cell is dependent on the amount of soil moisture in the subsurface.

- **Vapor Extraction Rate.** The rate of extraction of vapor from the vadose zone must be greater than the production of vapor to prevent vaporized contaminants from escaping to the atmosphere or from condensing in the vadose zone.

- **Impact to Surrounding Structures, Utilities, and Operations.** It must be possible to install the system at the C-400 Building site and to operate it with limited interference to site personnel and operations.

- **Vapor Treatment Criteria.** Emissions from the GAC vapor treatment system will be in accordance with criteria with which DOE and the Commonwealth of Kentucky Air Quality Control (QC) Board have agreed. In addition, an on-line VOC analyzer will be mounted in the GAC stack. This VOC analyzer will automatically shut down the SPH and VR systems if the emitted vapor exceeds one-half the permissible exposure limit for TCE. The permissible exposure limit for TCE is 100 ppmv, *so* the set-point for the system shut down is 50 ppmv.

4.4 STEPS TO PERFORM THE TREATABILITY STUDY

The SPH Design Package (DOE 2001b) and the *Construction Quality Control Plan for the Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1944&D2 (DOE 2001c), describe how the treatability study will be implemented.

4.5 AMOUNT OF REPLICATION

Refer to Appendix A of this TSWP for details regarding the Sampling and Analysis Plan (SAP), including the number of replicate analyses.

5. EQUIPMENT AND MATERIALS

The following subsections summarize equipment and materials necessary to construct and implement the SPH system.

5.1 CONSTRUCTION EQUIPMENT

In order to install the SPH system, a drilling rig capable of drilling a 14-in. hole to a total depth of 34 m (110 ft) bgs is required (i.e., an auger rig with 10-114 in. inside-diameter augers or other drilling system). Other necessary equipment includes equipment commonly associated with electrical utility installation (e.g., boom truck) and **a** forklift.

5.2 SIX-PHASE HEATING EQUIPMENT

The following generalized list of equipment and materials is necessary for installation of the SPH system. **A** complete list and specifications can be found in the **SPH** Design Package (DOE 2001b).

- Construction trailer
- Electrodes and associated components
- VR wells
- **SPH** power control unit
- Electric utility supply line
- Graphite or steel shot
- Computer
- Data acquisition software
- Temperature sensors
- Steam and vapor treatment system and accessories

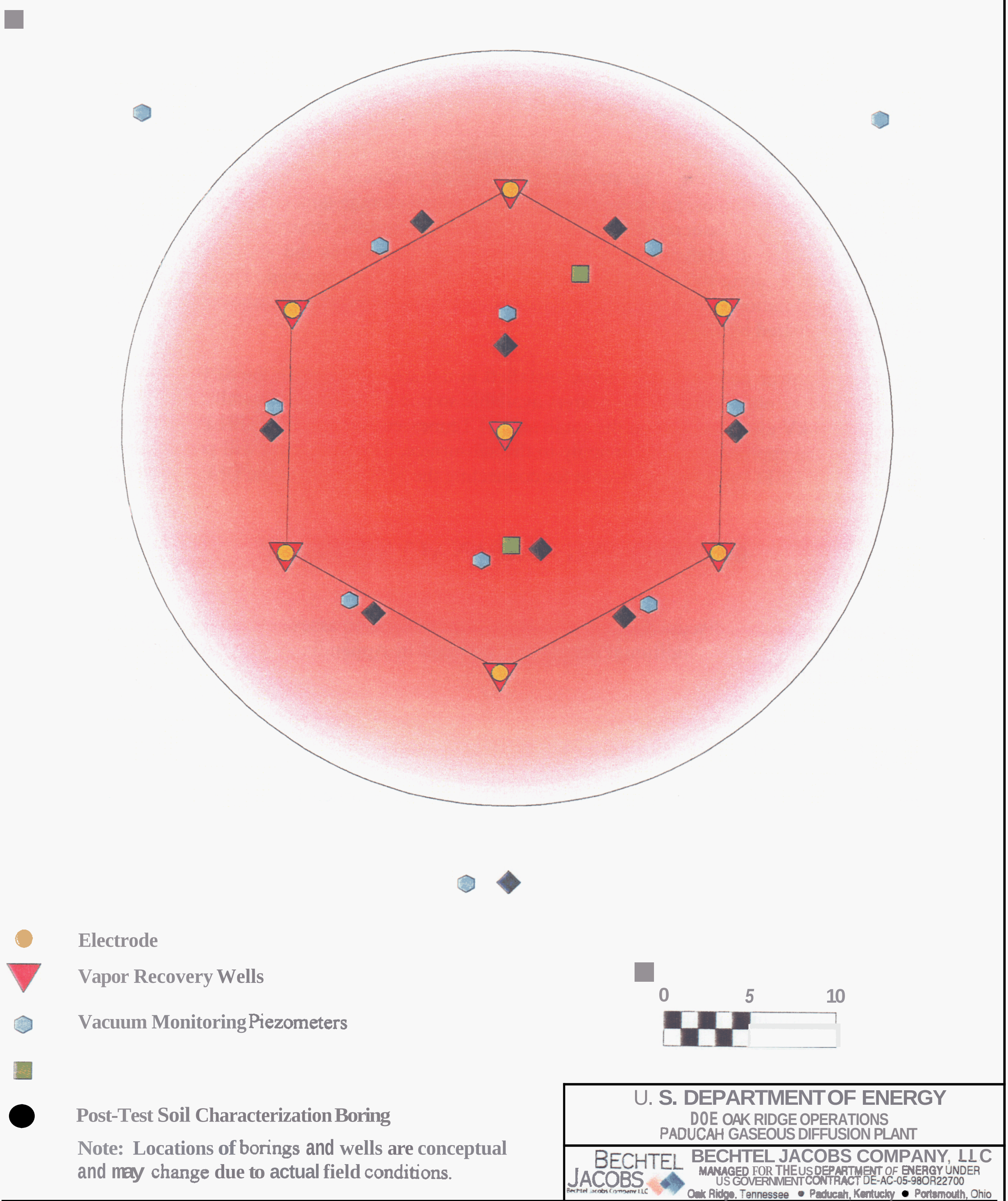

Fig. 6.1. **General** layout of test cell.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications
International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

FIGURE No. cell.ppt
DATE 07-13-01

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- VR system
- Soil sampling equipment
- Phone line, remote telemetry unit

5.3 SITE SPECIFIC RECOMMENDED ACTIONS

The area chosen for the SPH treatability study includes multiple structures related to current or former operations of the C-400 Building. The structures include an overhead crane system, a railroad track, a fence, below ground utility lines, an unused empty aboveground storage tank (AST), unused aboveground pipelines and pump system associated with the AST, and loading dock structures. In order to install the SPH system in the area of highest contamination, the fence as well as the aboveground pipeline and associated airline connecting the pump system with the AST must be removed. These structures will be reinstalled after installation is complete. The removal and reinstallation of the above-ground piping and fence will be coordinated by BJC.

An electrical power pole will need to be installed in the area adjacent to the SPH treatability study site. Electricity will be obtained from the nearest available source at the time of installation, which may be from a nearby 13.8-kV electrical line on the south side of Tennessee Avenue. The SPH PCU will reduce the supply voltage to the appropriate level to apply to the subsurface. The SPH team will provide any poles or lines required while USEC will be responsible for connecting the SPH system to the USEC power grid.

6. SAMPLING AND ANALYSIS PLAN

The following sections discuss the general sample requirements to assess effectiveness and operation of the SPH treatability study. Additional details are provided in Appendix A (the SAP) and in the SPH Design Package (DOE 2001b).

6.1 LOCATION OF THE TREATABILITY STUDY

The SPH treatability study will be conducted at the southeast comer of the C-400 Building, in what appears to be the primary source area for the Northwest Plume. Figure 1.2 (also Fig. A.l) shows the planned location for the treatability study test zone. This location was selected based on data collected during the WAG 6 RI conducted in 1997 (DOE 1999).

6.2 SAMPLING STRATEGY

This section discusses the general sampling strategy to be followed to evaluate the test objective and document the performance goals presented in Sect. 3. The overall sampling strategy for the treatability study will focus on the soils of the upper continental deposits, as well as UCRS and RGA groundwater. Analytes of interest are the organic compounds TCE; 1,1-dichloroethene (DCE); *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride (also known as TCE and its degradation products), as well as benzene, carbon tetrachloride, and chloroform; radionuclides; metals; the geochemical parameters of pH, oxidation-reduction potential (Eh), conductivity, dissolved oxygen, temperature, and soil moisture; and major anions and cations. Sampling for the treatability study will consist of three phases: preconstruction baseline sampling, operational sampling, and post-construction effectiveness sampling. As indicated in Fig. 6.1 (also Fig. A.2), a total of 35 borings is planned for the project (four vacuum monitoring piezometers are installed at more distant locations and are not shown on the Figures). Four of the borings are for multi-level groundwater and soil temperature monitoring wells. One of the groundwater monitoring wells will be placed upgradient of the heating zone, two of these borings are within the heating zone, and one boring will be placed downgradient of the heating zone. When completed as multi-level groundwater monitoring wells, each well will have up to seven sampling ports, which will make each well equivalent to a multi-well cluster. The four wells together will result in up to 28 sampling points.

Seven borings for electrode and VR well installations also are planned. Six of the borings are in a roughly hexagonal arrangement with the remaining boring in the center of the pattern. The electrodes installed in these borings will heat the soil, and the associated VR wells will recover the vapor created by the heat. There also are 15 vacuum monitoring piezometers that will measure the amount of vacuum applied to the subsurface by the VR system, provide steam vents at the UCRS/RGA interface, and act as backup VR points. Eleven of the 15 borings located within the zone of heating will be used to collect soil samples from the UCRS for characterization of pre-test contaminant levels.

At the conclusion of heating, nine soil borings will be installed to assist in determining the residual contamination concentrations and technology performance. These borings will be installed adjacent to selected piezometer borings in which baseline soil samples were collected to establish pre-test contaminant levels. The soil samples will be collected from the same depths as the baseline samples and analyzed for the same analytes and parameters tested for in the baseline soil samples.

6.2.1 Soil and Groundwater Sampling

Both soil and groundwater samples will be collected as part of the baseline sampling effort. Soil samples from the UCRS will be collected from 11 of the 15 vacuum monitoring piezometers during drilling. Soil samples will be collected every 1 m (2 ft) from ground surface to the top of the RGA, which is at a depth of approximately 17 m (56 ft) bgs.

Although soil samples can be collected from the RGA, the coarse texture of the gravel makes recovery of residual DNAPL difficult; therefore, groundwater samples will be the primary medium used to indicate the magnitude of RGA soil contamination. Groundwater samples will be collected from up to seven intervals in each of the four multi-port groundwater monitoring wells. Each well will sample one interval at the base of the UCRS gravel, five intervals through the RGA (interval spacing to be determined from the borehole geophysical log from boring 400-038), and one interval in the first upper McNairy sand to the total depth of approximately 34 m (110 ft). In each of the borings that extend to the base of the RGA, a soil sample will be collected across the Continental Deposits/McNairy Formation contact, or within the uppermost McNairy Formation, to aid in determining the presence of pooled DNAPL. Field analysis of this soil sample, based on readings of a photoionization detector (PID) and direct observations, will be used to assess the local presence of a DNAPL pool at the top of the McNairy Formation. For direct observation, the core either will be wrapped in a section of fabric sleeve treated with hydrophobic dye (flute membrane-type material) as it is removed from the core sleeve, or a hydrophobic dye will be applied to the core to stain areas containing DNAPL. If a significant thickness of pooled DNAPL is present at a soil boring site based on field observations, the boring will be terminated at the top of the McNairy Formation.

Additional groundwater sampling will be performed during the operational phase of the treatability study. One groundwater sampling event will occur when SPH operations are approximately 80% complete (near calendar day 104). A second groundwater sampling event will occur when SPH operations are about 90% complete (near calendar day 117) and will help determine when to end SPH operation. Actual scheduling for the two operational groundwater sampling events will be based upon best estimates of progress of the system in removing the contaminants from the subsurface.

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After the end of the soil heating operational period (before the soil and water have a chance to cool down), soil and groundwater samples will be collected again to evaluate the performance of the technology. Groundwater samples will be collected from the multi-port monitoring wells within one week after the heating phase of the treatability study is complete. Soil samples will be collected from nine borings drilled adjacent to the vacuum monitoring piezometers within two weeks of the completion of operational period.

6.2.2 Operational Sampling

During the operation phase of the treatability study, various parameters will be measured to ensure optimum performance of the overall system and to determine the operating requirements and costs of the system. The parameters to be measured include energy usage, contaminant recovery, steam extraction rates, vacuum readings, temperature readings, VOC adsorption efficiency of the GAC, water addition rates, and operating parameters of the system components.

6.2.3 Health and Safety Sampling

During the boring and well installation phases and the treatment phase of the project, a very small potential for exposure to TCE exists for site workers. While there is little potential for overexposure to TCE, real-time monitoring with alarming instruments and personnel sampling will be used to document that exposure levels were maintained well below the 50 parts per million (ppm) for an 8-hour time-weighted average **(TWA)** permissible exposure limit.

Site sampling for the potential exposure to TCE will be conducted for two days before any subsurface material is brought to the surface to establish baseline conditions at the work site. The sampling will be conducted following National Institute for Occupational Safety and Health method **1022** using sampling pumps and charcoal sorbent tubes.

Monitoring of the worker breathing zone will be conducted using an alarming direct-reading PID. Readings will be taken continuously while subsurface material is being brought to the surface. The PID will be calibrated before each day of use with a standard calibration gas, typically 100 ppm isobutylene, and at the end of each day, following the manufacturer's operating instructions. These calibration readings and the field readings will be entered into a monitoring log book. In addition, personnel sampling pumps will be used ten days per month on personnel most likely to receive exposure.

During heating operations, real-time monitoring of stack exhaust for TCE will be conducted using a fixed industrial PID monitor. This instrument will have an alarming capability and will be set to alarm at 25 ppm. In addition, two area PID monitors will be set up to monitor the ambient air conditions. These monitors will be checked per the manufacturer's instructions, and the TWA will be recorded daily. These PIDs also will be calibrated each day **of** use.

6.2.4 Waste Management Sampling

The SAIC Waste Coordinator will be responsible for sampling the solid and liquid investigation-derived waste as needed. During sampling, all appropriate health and safety concerns will be addressed. Sample materials from different containers will not be mixed, and only containers requiring further characterization will be sampled.

6.2.5 Analytical Requirements

During the treatability study, most analyses will be performed by a fixed-base laboratory contracted through the Sample Management Office. Specific analytical methods and procedures are described in the

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Quality Assurance Project Plan (QAPP) contained in Appendix B of this SPH treatability study. Certain parameters, such as pH, dissolved oxygen, temperature, and conductance, will be measured in the field using appropriate field instruments such as field test kits and in-line flow cells.

Waste characterization sampling will be conducted during the installation and operation of the SPH system. Waste characterization requirements are discussed in detail in the Waste Management Plan (WMP), Appendix D.

6.2.6 Sampling Schedule

Two soil sampling events are planned during the treatability study. One sampling event will precede the installation of the SPH system to establish baseline conditions. The second soil sampling event will occur within two weeks after the heating phase of the treatability study is complete.

Four groundwater sampling events are planned during the treatability study. The first sampling event will establish baseline conditions prior to SPH operation. The second groundwater sampling event will occur when SPH operations are about **80%** complete (near calendar day 104). The third groundwater sampling event will occur when SPH operations are about **90%** complete (near calendar day 117) and will help to determine when to end the SPH operation. The fourth groundwater sampling event will occur within one week after the heating phase of the treatability study is complete. Actual scheduling for the two interim groundwater sampling events will be based upon best estimates of progress of the system in removing contaminants from the subsurface.

7. DATA MANAGEMENT PLAN

This Data Management Plan describes the data management procedures to be implemented for the SPH treatability study at PGDP.

The data management program for the treatability study manages the life cycle of environmental measurements data from the planning of data for characterization and remediation decisions, through the collection, review, and actual usage of the data for decision-making purposes to the long-term storage of data. The environmental measurements data management process contains the following major activities: sampling and analysis planning, field preparation, field data collection, data review, data assessment, and data consolidation and use. The procedures for these activities are described in detail in Sects. 7.2 through 7.11. Sect. 7.1 lists roles and responsibilities of the persons involved in data management. Sect. 7.12 provides a discussion of Paducah Project Environmental Measurements System (PEMS), and Sect. 7.13 provides requirements for records management and document control.

7.1 PROJECT ROLES

The major roles of the persons involved in data and records management are summarized in the following text. One person may hold more than one role or responsibility. The roles are held primarily by DOE, DOE's Management and Integration (M&I) Contractor, and the M&I Contractor's Remedial Action Assessment Subcontractor (RAAS).

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7.1.1 Data Management Team

The Data Management Team is composed of a Project Data Coordinator and data management specialists, as necessary, to support the treatability study. The Project Data Coordinator will ensure that the requirements of the Data Management Plan are met. The Project Data Coordinator will be responsible for managing the site characterization and performance data for this project. This management activity will include accumulation, control, validation, and storage of site characterization and performance data as part of the project. The Project Data Coordinator also will assist the quality assurance (QA) staff in the review of laboratory procedures. He or she will ensure that all data are entered into Paducah PEMS including chain-o f-custody information, field measurements and data, laboratory data, and results of QC checks.

The Project Records Coordinator will be responsible for the project records. His or her duties will include all activities relating to identification, acquisition, classification, indexing, and storage of project records related to field activities. The project records include data documentation materials, plan and procedures, and all project file requirements.

7.1.2 M&I Contractor Data Manager

The M&I Contractor Data Manager will interface with the Project Data Coordinator to oversee Paducah PEMS use and to ensure that data deliverables meet M&I Contractor standards. The M&I Contractor Data Manager will enter information related to the fixed-base laboratory data packages and the tracking associated with the samples, once the samples have been shipped from the laboratory and the RAAS Contractor's Sample Coordinator has verified receipt of samples. The fixed-base laboratory electronic data deliverables (EDDs) and the field measurement data will be loaded into Paducah PEMS by the RAAS Contractor. The RAAS Contractor is responsible for data verification, validation and assessment, and for preparing the data for transfer from Paducah PEMS to the Paducah Oak Ridge Environmental Information System (OREIS). The M&I Contractor Data Manager is responsible for transferring the data from the ready-to-load files supplied by the RAAS Contractor to the Paducah OREIS database.

7.1.3 M&I Contractor Sample Manager

The M&I Contractor Sample Manager will develop the statement of work (SOW) to be performed by an analytical laboratory in the form of a project-specific laboratory SOW. Analytical methods, detection limits, minimum detectable activities, laboratory QC requirements, and deliverable requirements will be specified in this SOW. The M&I Contractor Sample Manager will provide the RAAS Contractor with a matrix template. The RAAS Project Chemist will determine the sampling requirements and submit the completed and approved sampling matrix to the M&I Contractor Sample Manager to assist in developing the laboratory SOW. The M&I Contractor Sample Manager will receive EDDs, perform contractual screenings, and distribute data packages. The M&I Contractor Sample Manager will interact with the Project Data Coordinator to ensure that hard-copy and electronic-deliverable formats are properly specified and will interface with the contract laboratory to ensure that the requirements are understood and met.

7.1.4 Data Validators

The RAAS Project Chemist will assign independent data validators who will ensure that analytical data are based on procedure number TP-DM-300-7. Data validation problems will be identified and appropriately resolved.

7.1.5 M&I Contractor Document Center Manager

The Document Center Manager will be responsible for the long-term storage of project records. He or she will interface with the Project Records Coordinator to ensure that document and records transmittals meet the M&I Contractor's standards and fulfill the requirements of the CERCLA Administrative Record.

7.2 EXISTING DATA

Background data, including geologic and hydrogeologic data, used to select the location and to support the design of the treatability study were obtained from the WAG *6* RI (DOE **1999).** Existing data for this project are stored in Paducah OREIS.

7.3 PROJECT ENVIRONMENTAL DATA COLLECTION

This TSWP identifies the tasks for project environmental data collection, including sampling and analysis planning, QA, waste management, health and safety, and data management planning. **A** laboratory SOW will be developed with the DOE-Oak Ridge Sample Management Office following regulatory approval of this TSWP.

7.4 FIELD ACTIVITY PREPARATION

Field preparation activities are performed to ready the site for field sampling operations. The data management tasks involved in field preparation include identifying all sampling locations and preparing descriptions of these stations, developing summaries of all the samples and analyses to be conducted at each sampling location, developing field forms for capturing field data, coordinating sample shipment/ delivery with off-site laboratories, and coordinating screening analyses with PGDP laboratories. These activities will be conducted by the RAAS Contractor Sample Coordinator working with the M&I Contractor's Sample Manager.

The RAAS Field Manager and RAAS Data Management Team will coordinate data management activities with field sampling activities according to procedure **RAAS-006,** "Data Management Coordination."

The RAAS Field Manager will review field forms for the collection of lithology, well construction, well purge/development, and groundwater sampling information for completeness. The field forms also will specify the appropriate type of information for each field. Copies of field forms will be sequentially numbered, and the number will be tracked in the field logbooks.

7.5 FIELD DATA COLLECTION

Paducah PEMS will be used to identify, track, and monitor each sample and associated data from point of collection through final data reporting. The tracking system for the treatability study will include field logbooks, field forms, chain-of-custody records, and hard copy data packages as well as EDDs.

Data management requirements for field logbooks and field forms specify that (1) sampling documentation must be controlled from preparation and initiation to completion, (2) all sampling documents generated must be maintained in a project file, and (3) modifications to planned activities and deviations from procedures shall be recorded. Field data documentation shall be maintained according to satellite document management center requirements outlined in RAAS-002, "Paducah Records Management."

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The comprehensive sampling list developed by the Field Manager and Sample Coordinator is used as the basis for finalizing the sample containers to be used for sample collection; ordering sufficient amount of containers, preservatives, and other supplies; and verifying the numbers of samples presented in the laboratory statements of work. Before the start of field sampling, the Sample Coordinator will specify the contents of sample kits, which will include sample containers, labels, preservatives, chain-of-custody records, and instructions for collecting samples. Samples labels will be completed according to procedures stated in this TSWP.

7.6 FIELD DATA

Field measurements will be recorded on appropriate field forms. These forms will be QC-checked against the field logbooks, and the data will be manually entered into Paducah PEMS using procedure TP-DM-300-2. Field gas chromatography results will be produced by the gas chromatography computer, and the data will be QC checked and then manually entered into Paducah **PEMS. A** QC check of this data entry will be made, which involves comparing printouts of the data in Paducah PEMS to the original field form or instrument printout if the field laboratory is not capable of producing an EDD.

7.7 SAMPLE ANALYSIS

Before the start of field sampling, the RAAS Field Manager and Sample Coordinator will coordinate the delivery of samples and the receipt of results with the M&I Contractor Sample Manager who, in turn, will coordinate with the contract laboratories. The **RAAS** Contractor's Sample Coordinator and the M&I Contractor Sample Manager will present a general sampling schedule to the off-site laboratories. The Sample Coordinator also will coordinate the receipt of sampling coolers and containers with the laboratories and determine any requirements for laboratory permission to ship. The M&I Contractor Sample Manager will ensure that hard-copy deliverables and EDDs from the laboratories contain the appropriate information and are in the correct formats.

7.8 LABORATORY ANALYTICAL DATA

All data packages and EDDs received from the laboratory will be tracked, reviewed, and maintained in a secure environment. Paducah PEMS and/or Paducah OREIS will be used for tracking all data. The primary individual responsible for these tasks will be the M&I Contractor Sample Manager. The following information will be tracked: sample delivery group number, date received, number of samples, sample analyses, receipt of EDD, and comments. The M&I Contractor Sample Manager will compare the contents of the data package with the chain-of-custody form and will identify discrepancies. Discrepancies will be reported immediately to the laboratory and the data validators. Copies of the Form I's from the data package will be distributed to the Project Chemist.

To evaluate the quality of laboratory EDDs, the EDDs for the first four data packages from each laboratory will be 100% QC-checked against the hard copy. The results and qualifier information from the EDD (presented in Form I format) will be checked, as will the format of all fields provided. The Project Data Coordinator will report immediately any discrepancies to the M&I Contractor Sample Manager *so* that the EDDs can be corrected and new EDDs issued. After QC of the first four packages, approximately one out of every ten EDDs will be checked to verify that the laboratory is continuing to provide adequate deliverables.

7.9 GEOGRAPHIC INFORMATION SYSTEM COVERAGE

The Paducah Geographic Information System network will be used for preparing maps used in data analysis and data reporting. Coverage anticipated for use during the project is as follows:

- stations (station coordinates will be downloaded from Paducah OREIS),
- facilities,
- solid waste management unit boundaries,
- groundwater plume contours,
- plant roads,
- plant fences,
- streams,
- utilities, and
- topographic contours.

No additional coverage is anticipated to be created during this project. Additional stations will, however, be added to Paducah OREIS.

7.10 DATA ASSESSMENT

Data assessment will be conducted and documented according to procedure RAAS-005. The data review process determines whether a set of environmental data satisfies the data requirements defined in the project scoping phase. This process involves the integration and evaluation of all information associated with a result. Data review consists of an evaluation of the following: data authenticity; data integrity; data usability; outliers; and precision, accuracy, representativeness, completeness, and comparability parameters.

7.11 VERIFICATION AND VALIDATION OF DATA

The Project Data Coordinator is responsible for ensuring that data verification occurs as outlined in RAAS-005. Data verification processes for laboratory data will be implemented for both hard copy data and EDDs. Additional requirements for data verification and validation are included in the QAPP, which is located in Appendix B of this TSWP. The data packages will be reviewed to ensure that all samples received the analyses requested. Discrepancies will be reported to the laboratory and the data validators. Electronic data verification of the EDDs will be performed as data are loaded into Paducah PEMS. The hard copy will be checked to ensure that missing fractions indeed were analyzed for, and the fractions missing from the EDD will be requested from the laboratory. Integrity checks in Paducah PEMS also will review the list of compounds generated by the laboratory to ensure that data for all requested analytes have been provided. Discrepancies will be reported to the laboratory and data validators.

The **RAAS** Project Chemist is responsible for ensuring that data are validated according to data management procedure TP-DM-300-7. The Project Chemist will assign independent data validators. Upon receipt of validated Form I's, the validated packages will be tracked. Validated results will be manually entered into Paducah PEMS. These results may include data validation qualifiers, subqualifiers (i.e., codes indicating the reason for validation), and changes to results or detection limits. **A** QC check will be made of the electronic data against the hard copy, validated, Form I's. In addition to verifying the validation changes, the QC check will verify the dates samples were received and analyzed, sample identification number, laboratory identification number, matrix, results, units, Chemical Abstract Service number, and radiological counting error (if applicable). This QC check will provide assurance that the laboratory data

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in the field electronic data management system are accurate. Form I is considered to be the accurate record. If the EDD does not match Form I, either the laboratory will be required to resubmit the EDD, or manual changes will be made to the data in Paducah PEMS.

7.12 DATA CONSOLIDATION, ANALYSIS, AND USE

The data consolidation process consists of the activities necessary to prepare the evaluated data for the users. The main users for the treatability study are the project team, which uses the data to develop project data reports, including the treatability study report. The M&I Contractor will store the data in Paducah OREIS database for future use.

Project reports include reports of the status of the sampling event, reports of data compared to various criteria such as reports of all data above detection limits ("hits reports") or data above preliminary remedial goals, and reports of the complete set of data. Data analysis will be documented in sufficient detail to allow re-creation of the analysis. Project reports, as defined previously, may be generated from Paducah PEMS. All official data reporting, as may be contained within the treatability study report or in other reports to outside agencies, must be generated from data stored in Paducah OREIS.

7.13 DATA MANAGEMENT SYSTEM REQUIREMENTS

Paducah PEMS will be used for the treatability study to manage field-generated data; import laboratory-generated data; update field and laboratory data based on data verification and validation; report data; and transfer data to Paducah **OREIS.** Requirements for addressing the day-to-day operations of Paducah PEMS include backups, security, and interfacing with the M&I Contractor Data and Sample Managers. System backups will be performed daily by the M&I Contractor Network Administrator.

Security of Paducah PEMS and of data generated during the treatability study data management effort is essential for the success of the project. The security precautions and procedures implemented by the Data Management Team will be designed to minimize the vulnerability of the data to unauthorized access or corruption. Only members of the Data Management Team will have access to Paducah PEMS, the hard-copy data files, and the diskettes and tape backups.

7.14 RECORDS MANAGEMENT AND DOCUMENT CONTROL

All field logbooks, site logbooks, diskette logs, chain-of-custody forms, data packages with associated QA/QC information, validation forms, and any field forms will be assigned document control numbers and maintained according to the requirement for a satellite document management center defined in **RAAS-002,** "Paducah Records Management."

Duplicates of all field records will be maintained until the completion of the project. The Field Technical Manager will copy all logbooks and field documentation weekly. The copies will be forwarded to the project files. The project file will be considered the Record Copy and, as such, will be stored in 1-hour-rated, fire-resistant, locked file cabinets. All electronic versions also will be stored in the project file; back-up copies will be maintained by the originator or the original recipient of the diskette.

All records will be assigned a document number that will be consistent and recognized by the PGDP Document Management Center. The procedure for records management is **RAAS-002,** "Paducah Records Management."

Upon completion of the project, the Project Records Coordinator will forward all original logbooks, field documentation, project deliverables, and Paducah PEMS to the PGDP Document Management Center. These project records will become part of the Administrative Record for the GWOU. The project files will be submitted in standard records storage boxes, measuring 40 × 32 × 25 cm (16 × 13 × 10 in.). Each box will contain an index of the contents and "PGDP Environmental Management and Enrichment Facilities Records Transmittal List" (CP-20445) and will be accompanied by a completed Material Transfer Form (CP-20443) with a cover letter to the attention of the M&I Contractor's Records Manager. All environmental data will be archived by the Project Data Coordinator or designee in accordance with procedure "Archival of Environmental Data within the ER Program" (RAAS-004).

8. DATA ANALYSIS AND INTERPRETATION

The results of the treatability study for SPH will be based upon analysis and interpretation of measurements of several media and properties. In overview, the data must be sufficient to assess the following:

- key operating parameters,
- zone of influence,
- thermal performance,
- treatment performance, and
- cost effectiveness.

To reach these goals, the data must be taken from pre-test and post-test measurements, as well as from measurements derived during the active operation of the SPH test cell.

8.1 SOURCES OF DATA

The data to be used in the evaluation of this treatability study will come from several different sources. Background data used to select the location of the SPH test cell, as well as geologic and hydrogeologic data to support the design, have been obtained chiefly from the WAG 6 RI (DOE 1999) and the FS for the GWOU (DOE 2001a). Temporary borings installed during the WAG 6 RI (DOE 1999) and the DNAPL zone conceptual model for the southeast C-400 block, in the FS for the GWOU (DOE 2001a), provide the basis for selecting the location of the SPH test cell. Appendix E of this TSWP, taken from the FS for the GWOU (DOE 2001a), presents the available data and documents the assumptions of the DNAPL zone conceptual site model.

Baseline and assessment characterization of the soil and groundwater contamination within the treatability study cell will be required to assess the treatment performance. Operations data are necessary, as well, for an assessment of the system performance. Measurements of properties of the area soil and groundwater will support the evaluation of the zone of influence and thermal performance for the SPH test cell.

Both field measurements and laboratory analyses will be crucial to the assessment of the treatability study. Issues related to data management and data quality are discussed in Sect. 6, *Sampling and Analysis*, and Sect. 7, *Data Management*. The following sections describe the types of data required to assess each of the major performance criteria and how the data will be used in this study. Table 8.1 summarizes key analyses for the SPH treatability study.

Table 8.1. Key measurements during the Treatability Study

Medium	Property	Type of Measurement	Timing of Measurement	Assessment
Soil	UCRS contaminant level	Laboratory	Pre-Study and Post-Study	TCE removal efficiency
	UCRS moisture	Laboratory	Pre-Study and Post-Study	Mass of steam generated
	UCRS and RGA temperature	Field	Operations	Heating efficiency Phase of TCE and water
	McNairy contaminant level	Field Laboratory	Baseline	Presence of DNAPL
Water	RGA contaminant level	Laboratory	Pre-Study, Operations, and Post-Study	TCE removal efficiency
Air	Vacuum	Field	Operations	VR zone of influence
Vapor	Contaminant level	Laboratory	Operations	TCE removal efficiency
	Volume	Field	Operations	Removal rate
Condensate	Contaminant level	Laboratory	Operations	TCE removal efficiency
	Volume	Field	Operations	Heating efficiency
Electricity	Power	Field	Operations	Applied energy
	Resistance	Field	Operations	Soil electrical resistance

8.2 BASELINE AND ASSESSMENT SAMPLING

Documentation of baseline soil and water contamination levels within the treatability study test cell is crucial to the assessment of treatment performance. Previous investigations have shown that conventional soil sampling and analysis techniques, with minor modification, are sufficient to characterize the residual DNAPL saturation within the UCRS. However, the collection of meaningful water samples, even from the more permeable, water-saturated zones of the UCRS, remains problematic. Thus, contaminant levels in soil samples will be the primary measure of treatment performance in both the vadose zone and saturated **UCRS.** Contaminant levels will be measured by standard laboratory methods. This analysis will not be relied upon to determine the physical state of TCE (i.e., dissolved, sorbed as ganglia, or free product). Adjacent pre-test and post-test samples from the SPH test cell and adjacent soils will be used as an empirical assessment of the efficiency of contaminant removal.

In addition to analyses of contaminant levels, baseline and assessment samples of UCRS soils will be tested for soil moisture. **A** plot of the percent contaminant removal versus weight percent moisture removed for all adjacent UCRS soil sample pairs will be used as an assessment of TCE removal as a function of steam creation within the UCRS.

Conversely, the coarse textured RGA sediments previously have not yielded adequate soil samples for analysis to support a meaningful assessment of DNAPL saturation. Although dissolved contaminant levels are only an indirect measure of DNAPL saturation, groundwater samples remain a more reliable indicator of DNAPL levels in the **RGA** than do soil samples. To support baseline and assessment sampling of the treatability study, as well as the assessment of the progress of the study, groundwater samples will be collected from monitoring wells installed within the treatability study cell.

While both soil and groundwater analyses yield quantitative data, both media samples are discrete volumes that, at best, can only approximate the in-place conditions. The primary means of analyzing the data will be comparison of the percent contaminant removal in adjacent samples. Bar graphs will be a primary means of visualizing the data.

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8.3 OPERATIONS MONITORING

Several parameters will be measured during the operation of the SPH system to support an assessment of the effects of heating on selected properties of soil, groundwater, and DNAPL. Records of applied power and mass of contaminants and water removed are key to the assessment of performance. Measurements of condensate volume, applied/derived vacuum, and temperature can be used to assess the changing properties of the soil, groundwater, and DNAPL.

Plots of applied power versus time—both as power use, in kilowatts, and cumulative energy applied to the soil, as kilowatt-hours—will be used to show trends during the operation period. These trends will be compared to changes in the mass removal rate, graphed as pounds of contaminant versus time, to monitor the performance of the treatability study. The trends of these parameters over time will be a key measure of the completion of the SPH test cell operation. Moreover, upon completion of operation, the cumulative energy applied to the soil will be a component of the assessment of the cost of the technology per volume of soil treated.

The primary means to assess the thermal performance of the treatability study will be a plot of temperature versus time, evaluated at the following: (1) discrete locations, (2) through the depth of the test cell, and (3) along a radius extending from the center of the test cell to outside the treated zone. These data will provide not only a measure of the thermal properties of the soil, groundwater, and DNAPL media within the test cell, but also will define the extent of the treated zone and monitor for key occurrences, such as the initiation of boiling of DNAPL and groundwater. The volume of soil heated above the boiling point of the DNAPL and groundwater will define the volume of treated soil for a comparison against the cost of the treatability study.

The definition of the developing extent of the heated volume can be compared to a plot of average phase resistance of the electrodes to qualitatively assess the effects of heating on the electrical resistance of the soil. The treatability study will measure the combined flow of steam and condensate from the test cell and the pressure drop over which the flow occurs. By plotting the resultant of dividing flow by pressure versus time, the trends are a qualitative assessment of the change in permeability of the soils.

The cost effectiveness of the SPH technology can be calculated several different ways. The method easiest to document is the total cost of the project divided by the volume or weight of contaminants recovered, to get a cost-per-unit volume or unit weight. However, if a comparison between the reduction of contaminants in the subsurface and the amount of contaminants recovered suggests that some contaminants were destroyed in place, a better value would be the total costs divided by the total reduction in Contaminants. Some of the cost numbers for a **TS** are higher per unit volume treated than for a full-scale implementation because of economy-of-scale issues. Due to the complicated factors, the cost-effectiveness analysis will start with the simplest calculation, then develop numbers to account for those variations.

9. HEALTH AND SAFETY

An Environmental, Safety, and Health Plan (ES&HP) is located in Appendix C. It establishes the specific applicable standards and practices to be used during execution of the treatability study to protect the safety and health of workers, the public, and the environment. The ES&HP incorporates directly, or by reference, federal and state standards, pertinent consensus standards, and applicable contract requirements. The ES&HP will be implemented in accordance with 29 CFR 1926.65, Hazardous Waste Operations and Emergency Response. Additional specific health and safety requirements will be incorporated into the

ES&HP for the various field activities that comprise the treatability study through completion of activity hazard analyses.

The ES&HP will evolve as “lessons learned” are incorporated to continuously improve work processes while, maintaining focus on the functions and guiding principles of the Integrated Safety Management System and the zero-accident performance philosophy. The ES&HP will be completed and approved before commencing fieldwork.

10. WASTE MANAGEMENT

A project-specific WMP that addresses residuals that may be generated by this project is located in Appendix D.

11. COMMUNITY RELATIONS

Current stakeholders for the PGDP site, through the Citizens Advisory Board, are interested in reducing contaminant source areas that contribute to the groundwater contamination at PGDP. The SPH technology is capable of dramatically reducing the volume of TCE and any of its degradation products contributing to groundwater contamination. **A** formal presentation of this technology to the stakeholders is planned. The deployment **of** the SPH technology for the PGDP site was recommended to the stakeholders by the Innovative Technology Remediation Demonstration group.

Treatability study information will be included in the appropriate stakeholder-related activities as described in the ***Community Relations Plan for the Environmental Management and Enrichment Facilities Program, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 1998). These activities include distributing information bulletins, maintaining an information repository, and facilitating public meetings, including meetings for the Citizens Advisory Board. In addition, a project-specific fact sheet will be published and distributed, The fact sheet will focus on the treatability study and how it relates to the PGDP remediation strategy.

12. REPORTING

Following the completion of field work and data validation, the data will be evaluated and a report will be prepared to document fully the treatability study results and interpret the generated data. In particular, the report will focus on the performance of the SPH system and allow evaluation of the technology for groundwater plume remediation at the PGDP. The report will generally follow the format suggested in EPA’s ***Guide for Conducting Treatability Studies under CERCLA*** (EPA 1992). The suggested outline for the treatability study report is shown in Fig. 12.1. This TSWP will be provided to state and federal regulators **as a** secondary document pursuant to the FFA (EPA 1998).

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Treatability Study Report Outline

1. Introduction
    - 1.1 Site description
        - 1.1.1 Site name and location
        - 1.1.2 History of operations
        - 1.1.3 Prior removal and remediation activities
    - 1.2 Waste stream description
        - 1.2.1 Waste matrices
        - 1.2.2 Pollutants/chemicals
    - 1.3 Treatment technology description
        - 1.3.1 Treatment process and scale
        - 1.3.2 Operating features
    - 1.4 Previous treatability studies at the site

2. Conclusions and Recommendations
    - 2.1 Conclusions
    - 2.2 Recommendations

3. Treatability Study Approach
    - 3.1 Test objectives and rationale
    - 3.2 Experimental design and procedures
    - 3.3 Equipment and materials
    - 3.4 Sampling and analysis
        - 3.4.1 Waste stream
        - 3.4.2 Treatment process
    - 3.5 Data management
    - 3.6 Deviations from the work plan

4. Results and Discussion
    - 4.1 Data analysis and interpretation
        - 4.1.1 Analysis of waste stream characteristics
        - 4.1.2 Analysis of treatability study data
        - 4.1.3 Comparison to test objectives
    - 4.2 Quality assurance/quality control
    - 4.3 Costs/schedule for performing the treatability study
    - 4.4 Key contacts

5. References

Appendices
- A. Data summaries
- B. Standard operating procedures

(Source: **EPA 1992)**

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Oh

SAIC
Science Applications International Corporation
P.O Box2502
Oak Ridge. Tennessee 37831

Fig. 12.1. Treatability study report outline.

FIGURE No. outline.ppt
DATE 06-01-01

13. SCHEDULE

Fig. 13.1 contains a schedule for the treatability study activities through completion of the operational phase of the field test.

14. MANAGEMENT AND STAFFING

This section presents the general management and staffing plan for the treatability study. The organization chart shown in Fig. 14.1 outlines the management structure that will be used for implementing the field-scale treatability study. Although not shown in this figure, the DOE Project Manager provides technical and management oversight. The DOE Project Manager also serves as the primary interface between the EPA and the Commonwealth **of** Kentucky. Key roles and their responsibilities for functions shown on the organizational chart are outlined in Table 14.I.

15. REFERENCES

DOE (U.S. Department of Energy) 1998. *Community Relations Plan for the Environmental Management and Enrichment Facilities Program, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1233&D3, U.S. Department of Energy, Paducah, KY, January.

DOE 1999. *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1727&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 2001a. Draft *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1857&D1, U.S. Department of Energy, Paducah, KY, June.

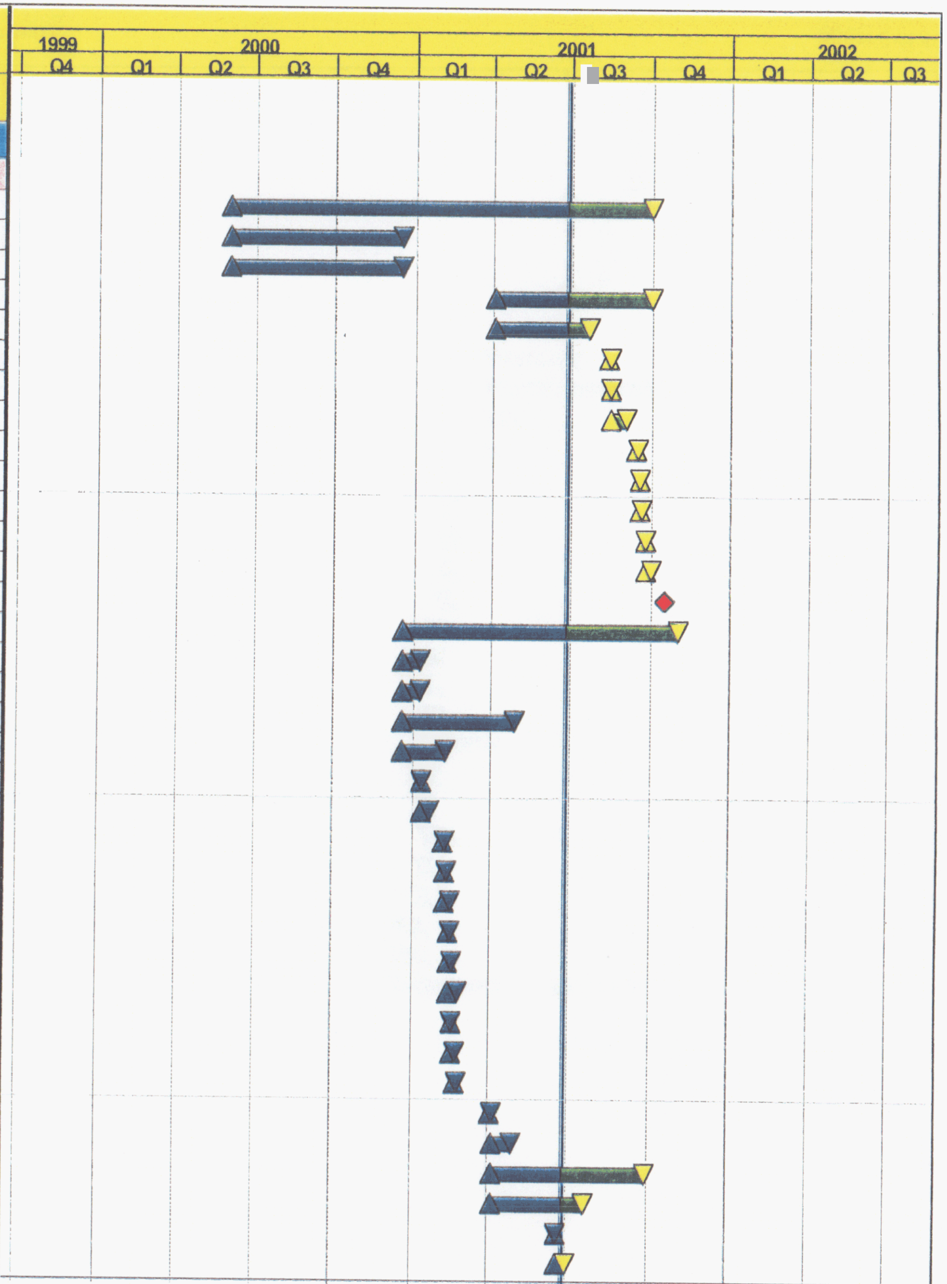
DOE 2001b. *90% Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1921&D1/R1, U.S. Department of Energy, Paducah, KY, August.

DOE 2001c. *Construction Quality Control Plan for the Six-Phase Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1944&D2, Paducah, KY, August.

EPA (U.S. Environmental Protection Agency) 1992. *Guide for Conducting Treatability Studies under CERCLA,* Office of Solid Waste and Emergency Response (OSWER) Directive No. 9380.3-10, EPA/540/R-92/071a, U.S. Environmental Protection Agency, Washington, DC, October.

EPA 1998. *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant,* U.S. Environmental Protection Agency, Atlanta, GA, February 13.

Activity ID	Activity Description	Cal Days	Cal ID	Early Start	Early Finish
Remedial Action Assessment					
Professional Services					
Delivery Order Releases					
A9.046.000	6-Phase Soil Heating Work Plans	487*	2	02JUN00A	01OCT01
A9.046.002	Work Plan - D(-1)/D0/D1	197*	2	02JUN00A	15DEC00A
A9.046.003	Work Plan	137	2	02JUN00A	15DEC00A
A9.046.004	Work Plan - D2	182*	2	03APR01A	01OCT01
A9.046.005	Revise D2 Work Plan	31	2	03APR01A	20JUL01
A9.046.007	Receive Comments from BJC	1	2	13AUG01	13AUG01
A9.046.008	Draft CRT - D2 Work Plan	1	2	14AUG01	14AUG01
A9.046.009	Revise D2 Work Plan	18	2	14AUG01	31AUG01
A9.046.010	Receive Comments	1	2	14SEP01	14SEP01
A9.046.011	Draft CRT - Revised D2 Work Plan	1	2	17SEP01	17SEP01
A9.046.015	Draft CRT - D2 Work Plan	3	2	17SEP01	19SEP01
A9.046.016	Comment Resolution Meeting	1	2	24SEP01	24SEP01
A9.046.017	Final CRT/Errata Sheets - D2 Work Plan	7	2	25SEP01	01OCT01
A9.046.018	Receive Approval for D2 Work Plan	0	2		15OCT01
A9.046.200	6-Phase Soil Heating Design	319*	2	19DEC00A	02NOV01
A9.046.202	Design - 30%	21*	2	19DEC00A	08JAN01A
A9.046.203	Prepare Draft CRT - 30% Design	20	2	19DEC00A	08JAN01A
A9.046.204	Design - 60%	130*	2	19DEC00A	27APR01A
A9.046.205	Revise Document - 60% Design	46	2	19DEC00A	05FEB01A
A9.046.206	Comment Resolution Meeting	1	2	10JAN01A	10JAN01A
A9.046.207	Final CRT - 30% Design	9	2	11JAN01A	19JAN01A
A9.046.209	Receive Comments from BJC	1	2	05FEB01A	05FEB01A
A9.046.210	Draft CRT - 60% Design	2	2	06FEB01A	07FEB01A
A9.046.211	Revise 60% Design	7	2	06FEB01A	12FEB01A
A9.046.212	Receive Comments from BJC	1	2	12FEB01A	12FEB01A
A9.046.213	Draft CRT - 60% Design	2	2	12FEB01A	14FEB01A
A9.046.214	Revise 60% Design	8	2	12FEB01A	22FEB01A
A9.046.215	Comment Resolution Meeting	1	2	15FEB01A	15FEB01A
A9.046.216	Final CRT - 60% Design	1	2	16FEB01A	19FEB01A
A9.046.217	DOE Certification Meeting	1	2	21FEB01A	21FEB01A
A9.046.218	Receive Comments - 60% Design	1	2	03APR01A	03APR01A
A9.046.219	Draft CRT - 60% Design	7	2	04APR01A	27APR01A
A9.046.220	Design - 90%	178*	2	04APR01A	28SEP01
A9.046.221	Revise Document - 90% Design	31	2	04APR01A	20JUL01
A9.046.222	Comment Resolution Meeting	1	2	18JUN01A	18JUN01A
A9.046.223	Final CRT - 90% Design	5	2	19JUN01A	28JUN01



Start Date	17SEP99
Finish Date	28DEC07
Data Date	25JUN01
Run Date	18JUL01 09:48

Early Bar
Progress Bar
Critical Activity

PADP

Sheet 1 of 4

Fig. 13.1. Schedule for treatibility study activities

Activity ID	Activity Description	Cal Days	Cal ID	Early Start	Early Finish
Delivery Order Releases					
A9.046.224	Receive Comments	1	2	13AUG01	13AUG01
A9.046.225	Draft CRT - 90% Design	18	2	14AUG01	31AUG01
A9.046.226	Revise Document - 90% Design	18	2	14AUG01	31AUG01
A9.046.227	Receive Comments	1	2	14SEP01	14SEP01
A9.046.228	Draft CRT - Revised 90% Design	3	2	17SEP01	19SEP01
A9.046.229	Revise Document	15	2	17SEP01	01OCT01
A9.046.233	Comment Resolution Meeting	1	2	24SEP01	24SEP01
A9.046.234	Final CRT	4	2	25SEP01	28SEP01
A9.046.235	Design - CFC	25*	2	09OCT01	02NOV01
A9.046.237	Recieve Comments	1	2	09OCT01	09OCT01
A9.046.238	Draft CRT - CFC Design	6	2	10OCT01	15OCT01
A9.046.239	Revise Document - CFC Design	6	2	10OCT01	15OCT01
A9.046.240	Submit CFC Design to DOE	0	2		22OCT01
A9.046.245	Receive Approval of CFC Design	1	2	02NOV01	02NOV01
A9.046.250	Field Mobilization	17	2	05NOV01	21NOV01
A9.046.300	6-Phase Soil Heating - CQCP	302*	2	18DEC00A	15OCT01
A9.046.302	QCCP - D(-1)	32*	2	18DEC00A	18JAN01A
A9.046.303	D(-1) CQCP	28	2	18DEC00A	12JAN01A
A9.046.304	Receive Comments from BJC	1	2	16JAN01A	16JAN01A
A9.046.305	Draft CRT - D(-1) CQCP	2	2	17JAN01A	18JAN01A
A9.046.306	CQCP - D0	32*	2	19JAN01A	19FEB01A
A9.046.307	Submit D0 CQCP	1	2	19JAN01A	19JAN01A
A9.046.308	Receive Comments from BJC	1	2	26JAN01A	26JAN01A
A9.046.309	CQCP - D1	92*	2	26JAN01A	27APR01A
A9.046.310	Prepare D1 CQCP	11	2	26JAN01A	05FEB01A
A9.046.311	Draft CRT - D0 CQCP	3	2	26JAN01A	30JAN01A
A9.046.312	Comment Resolution Meeting	1	2	31JAN01A	31JAN01A
A9.046.313	Final CRT - D0 CQCP	5	2	29JAN01A	19FEB01A
A9.046.314	Receive Comments from BJC	1	2	05FEB01A	12FEB01A
A9.046.315	Draft CRT - D1 CQCP	2	2	12FEB01A	14FEB01A
A9.046.316	Revise D1 CQCP	7	2	12FEB01A	22FEB01A
A9.046.320	Comment Resolution Meeting	1	2	15FEB01A	15FEB01A
A9.046.321	Final CRT - D1 CQCP	1	2	16FEB01A	19FEB01A
A9.046.323	Receive Comments - D1	1	2	03APR01A	03APR01A
A9.046.324	Draft CRT - D1 CQCP	7	2	04APR01A	27APR01A
A9.046.325	CQCP - D2	195*	2	04APR01A	15OCT01
A9.046.326	Revise Document - D2 CQCP	31	2	04APR01A	20JUL01
A9.046.327	Comment Resolution Meeting	1	2	18JUN01A	18JUN01A
A9.046.328	Final CRT - D2 CQCP	5	2	19JUN01A	28JUN01
A9.046.329	Receive Comments	1	2	13AUG01	13AUG01
A9.046.330	Draft CRT - D2 CQCP	2	2	14AUG01	15AUG01
A9.046.331	Revise Document - D2 CQCP	18	2	14AUG01	31AUG01
A9.046.332	Receive Comments	1	2	14SEP01	14SEP01
A9.046.333	Draft CRT - D2 CQCP	3	2	17SEP01	19SEP01
A9.046.338	Comment Resolution Meeting	1	2	24SEP01	24SEP01
A9.046.339	Final CRT - D2 CQCP	7	2	25SEP01	01OCT01

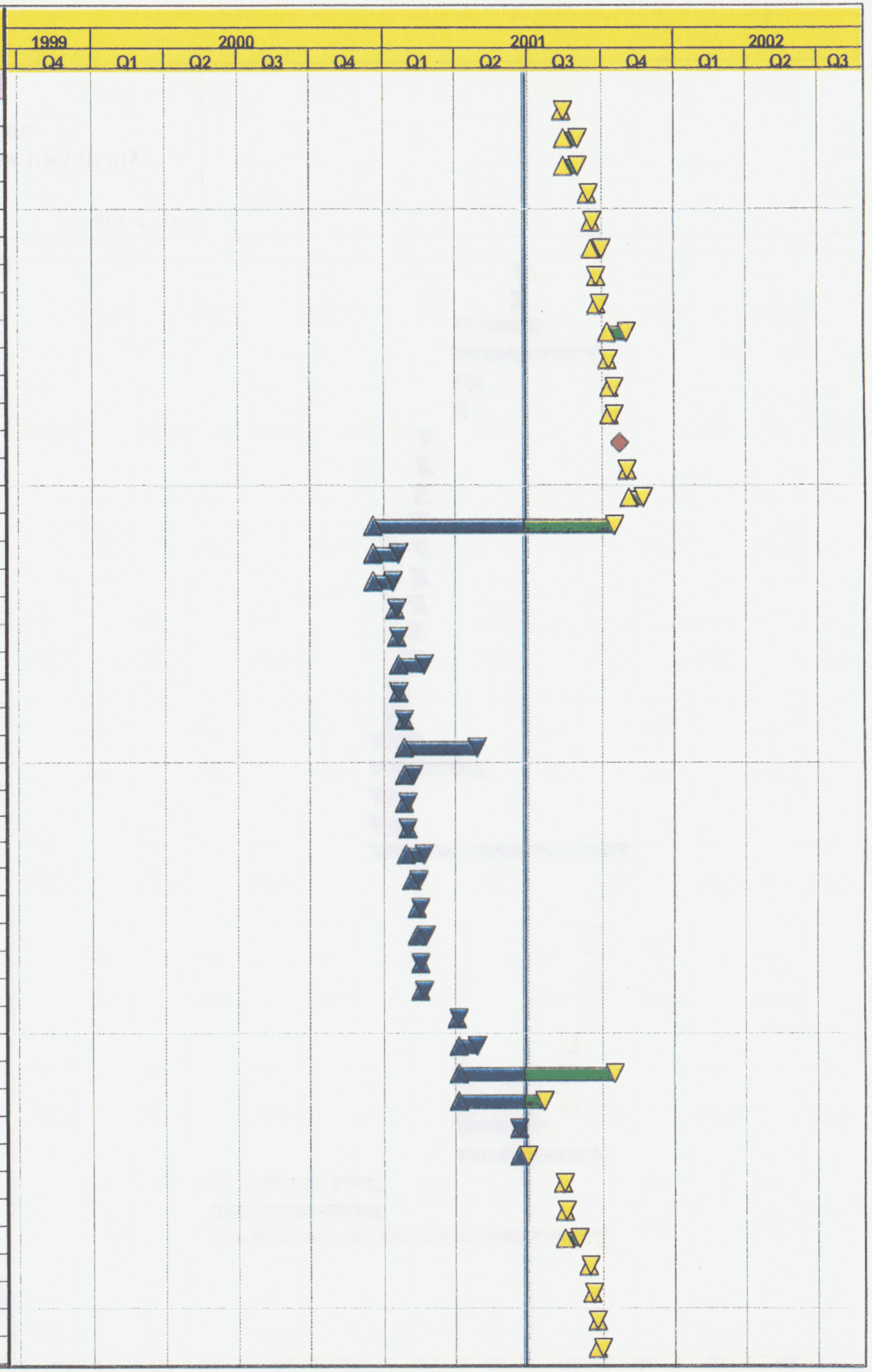


Fig. 13.1. (continued)

Activity ID	Activity Description	Cal Days	Cal ID	Early Start	Early Finish
Delivery Order Releases					
A9.046.340	Receive Approval - D2 CQCP	0	2		15OCT01
A9.046.370	Auditable Safety Analysis	236*	2	22FEB01A	15OCT01
A9.046.371	ASA of 60& Design Package	38	2	22FEB01A	02APR01A
A9.046.372	Receive ASA Report on 60% Design Pkg	1	2	19APR01A	19APR01A
A9.046.373	Comments on ASA Report	1	2	25APR01A	25APR01A
A9.046.374	ASA of 90% Design Package	28	2	20JUL01	16AUG01
A9.046.375	Comments on ASA Report on 90% Design Pkg	1	2	23AUG01	23AUG01
A9.046.376	ASA Report for CFC Design Package	15	2	01OCT01	15OCT01
A9.046.400	6-Phase Soil Heating Field Work	260*	2	05NOV01	22JUL02
A9.046.401	Construction Start	0	2	05NOV01	
A9.046.407	Vacuum Monitoring Points	88*	2	24NOV01	19FEB02
A9.046.408	Vacuum Monitoring Point 1	6	2	24NOV01	29NOV01
A9.046.409	Vacuum Monitoring Point 2	9	2	01DEC01	09DEC01
A9.046.410	Vacuum Monitroing Point 3	6	2	10DEC01	15DEC01
A9.046.411	Vacuum Monitoring Point 4	9	2	16DEC01	24DEC01
A9.046.412	Vacuum Monitoring Point 5	5	2	29DEC01	02JAN02
A9.046.413	Vacuum Monitoring Point 6	6	2	03JAN02	08JAN02
A9.046.414	Vacuum Monitoring point 7	5	2	12JAN02	16JAN02
A9.046.415	Vacuum Monitoring Point 8	7	2	17JAN02	23JAN02
A9.046.416	Vacuum Monitoring Point 9	9	2	28JAN02	05FEB02
A9.046.417	Vacuum Monitoring Point 10	6	2	06FEB02	11FEB02
A9.046.418	Vacuum Monitoring Point 11	8	2	12FEB02	19FEB02
A9.046.41A	Vacuum Monitoring Point 12	6	2	20FEB02	25FEB02
A9.046.41B	Vacuum monitoring Point 13	5	2	02MAR02	06MAR02
A9.046.41C	Vacuum Monitoring Point 14	6	2	07MAR02	12MAR02
A9.046.41D	Vacuum Monitoring Point 15	6	2	16MAR02	21MAR02
A9.046.41E	Electrode/SVE Installation	68*	2	22MAR02	28MAY02
A9.046.420	Electrode/SVE Installation 1	10	2	22MAR02	31MAR02
A9.046.421	Electrode/SVE Installation 2	7	2	01APR02	07APR02
A9.046.422	Electrode/SVE Installation 3	11	2	08APR02	18APR02
A9.046.423	Electrode/SVE Installation 4	10	2	20APR02	29APR02
A9.046.424	Electrode/SVE Installation 5	8	2	30APR02	07MAY02
A9.046.425	Electrode/SVE Installation 6	8	2	11MAY02	18MAY02
A9.046.426	Electrode/SVE Installation 7	10	2	19MAY02	28MAY02
A9.046.427	Multiport Installation/Development	49*	2	29MAY02	16JUL02
A9.046.428	Multiport Well Installation 1	6	2	29MAY02	03JUN02
A9.046.429	Multiport Well Installation 2	7	2	04JUN02	10JUN02
A9.046.430	Multiport Well Installation 3	5	2	11JUN02	15JUN02
A9.046.431	Multiport Well Installation 4	7	2	16JUN02	22JUN02
A9.046.432	Multiport Well Development 1	4	2	23JUN02	26JUN02
A9.046.433	Surface Well Installation	31	2	30JUN02	30JUL02
A9.046.434	Multiport Well Development 2	4	2	30JUN02	03JUL02
A9.046.435	Multiport Well Development 3	4	2	04JUL02	07JUL02
A9.046.436	Multiport Well Development 4	7	2	08JUL02	14JUL02
A9.046.437	Multiport System Installation 1&2	1	2	15JUL02	15JUL02
A9.046.438	Multiport System Installation 3&4	1	2	16JUL02	16JUL02

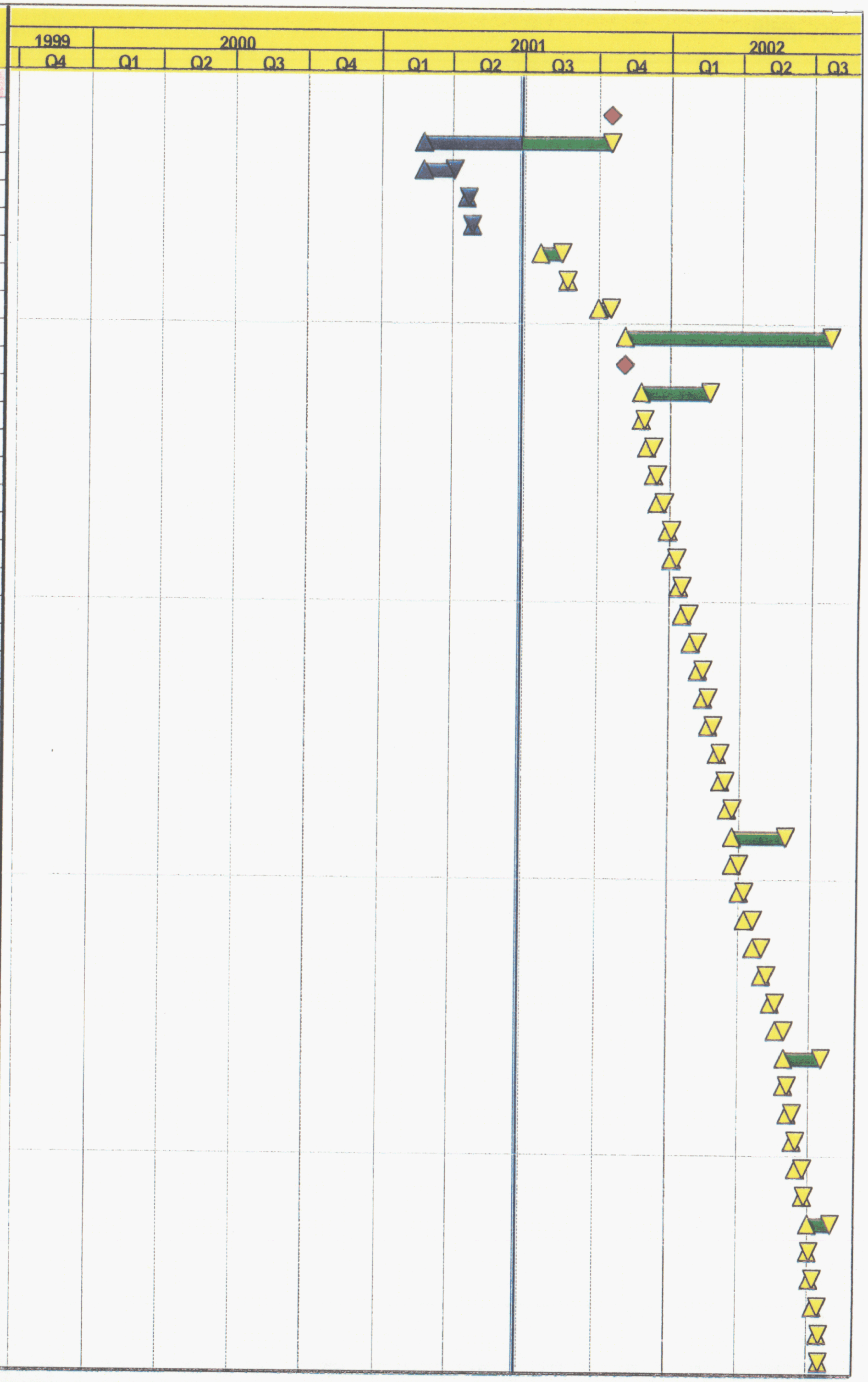
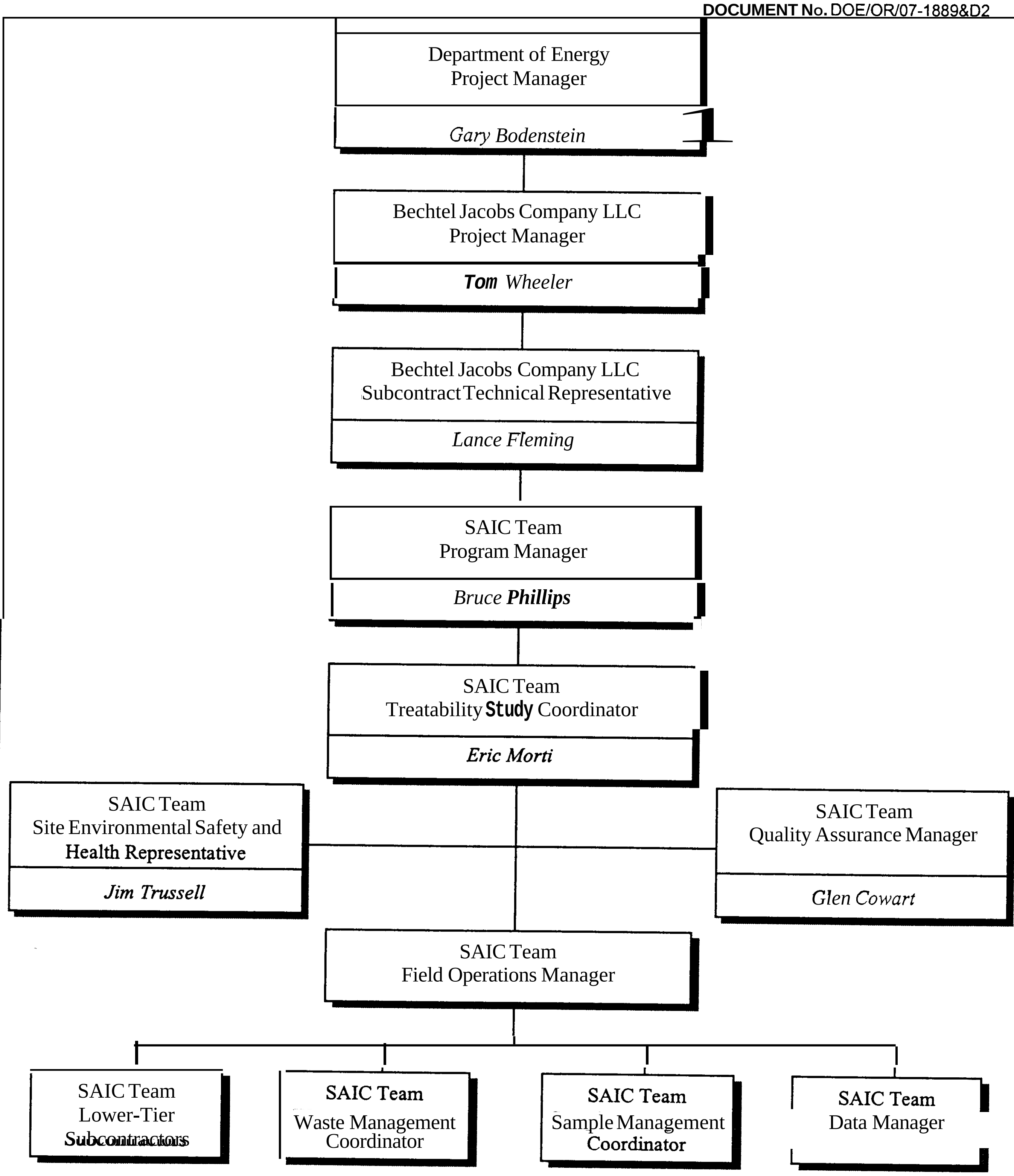


Fig. 13.1. (continued)

Activity ID	Activity Description	Cal Days	Cal ID	Early Start	Early Finish
Delivery Order Releases					
A9.046.439	Baseline Groundwater Sampling	6	2	17JUL02	22JUL02

Fig. 13.1. (continued)



U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications
International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. 14.1. Organizational chart.

FIGURE No. orgchart.ppt
DATE 06-01-01

504892

Table 14.1. Roles and responsibilities

Role	Responsibility
DOE Project Manager	Responsible for project oversight; will review and approve the TSWP, SPH design package, and CQCP; will participate in readiness reviews; responsible for communication with state and federal regulatory agencies.
M&I Contractor Manager	Responsible programmatically for technical, financial, and scheduling matters; will interface with DOE and regulators as appropriate.
M&I Contractor STR	Responsible for management and integration of subcontractor implementation of this treatability study.
M&I Subcontractor Program Manager	Ensures overall quality of subcontractor's projects under the general order contract; ensures project goals and objectives are met in a high-quality, timely manner; responsible for allocating resources throughout the project, communicating with M&I Contractor.
M&I Subcontractor Field Operations Manager	Responsible for implementing the treatability study, including all plans and field activities conducted as part of the treatability study including monitoring the performance of construction, sampling, and waste management activities; serves as the technical lead and principle point of contact with the Program Manager and STR; tracks project budget and schedules and delegates specific responsibilities to project team members; responsible for preparing any field change orders.
M&I Subcontractor Site Environmental, Safety, and Health Representative	Ensures that health and safety procedures designed to protect personnel are maintained throughout the field effort for this project; ensures the implementation of an Integrated Safety Management System for all aspects of the treatability study implementation.
M&I Subcontractor QA Manager	Provides QA oversight and approval for the project; conducts audits and surveillances and approves any field changes that may impact the project quality.
M&I Subcontractor Lower-Tier Subcontractors	Responsible for providing the labor and expertise in implementing the field-scale treatability study.
M&I Subcontractor Waste Management Coordinator	Ensures adherence to the WMP; documents and tracks field-related activities, including waste generation and handling, waste characterization sampling, waste transfer, and waste labeling.
M&I Subcontractor Sample Management Coordinator	Responsible for coordinating sampling activities, including coordination with the M&I Contractor sample management office; ensures all QC sampling requirements are met, chain-of-custody forms are properly generated, and compliance with off-site shipping requirements is achieved.
M&I Subcontractor Data Manager	Responsible for managing data generated during the field-scale treatability study in accordance with the data management plan.

15. REFERENCES

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APPENDIX A

SAMPLING AND ANALYSIS PLAN
FOR
SIX-PHASE HEATING TREATABILITY STUDY WORK PLAN

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CONTENTS

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FIGURES

TABLES

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ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
CFR	Code of Federal Regulations
DCE	1,1-dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOT	U.S. Department of Transportation
Eh	oxidation-reduction potential
EMEF	Environmental Management and Enrichment Facilities
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
FID	flame ionization detector
FTM	Field Task Manager
GAC	granular-activated carbon
HP	health physics
M&I	management and integration
NTU	nephelometric turbidity units
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PCU	power control unit
pH	logarithm of the hydrogen-ion concentration
PID	photoionization detector
ppm	parts per million
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RGA	Regional Gravel Aquifer
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SPH	Six-Phase Heating
STR	Subcontract Technical Representative
TCE	trichloroethene
TS	treatability study
TSWP	Treatability Study Work Plan
TWA	time-weighted average
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
VR	vapor recovery
WAG	waste area group
WMP	Waste Management Plan

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and act as backup VR points. Eleven of these borings within the zone of heating will be used to collect soil samples from the UCRS for characterization of pre-test contaminant levels.

At the conclusion of heating, nine soil borings will be installed to assist in determining the residual contamination concentrations and technology performance. These borings will be installed adjacent to selected piezometer borings in which baseline soil samples were collected. The soil samples will be collected from the same depths as the baseline samples and analyzed for the same analytes and parameters tested for in the baseline soil samples.

1.2.1 Soil and Groundwater Sampling

Both soil and groundwater samples will be collected as part of the baseline sampling effort after the start of fieldwork but before the soil heating operational phase of the project. Soil samples from the UCRS will be collected from 11 of the 15 vacuum monitoring piezometers being drilled. Soil samples will be collected every 0.6 m (2 A) from ground surface to the top of the RGA, which is at a depth of approximately 17 m (56 ft) bgs. Up to 28 soil samples will be collected fiom each of the 11 borings. The soils will be analyzed for VOCs, radionuclides, metals, and soil moisture. Baseline soil temperature profiles will be developed by collecting data from thermocouples strapped to the outside of the groundwater monitoring wells and attached to the 11 vacuum monitoring piezometers located within the zone of heating.

In each boring that extends to the base of the RGA, a soil sample will be collected across the RGA/McNairy Formation contact, or within the uppermost McNairy Formation, to aid in determining the presence of pooled dense nonaqueous-phase liquid (DNAPL). Field analysis of these soil samples, based on reading of a photoionization detector (PID) and direct observations, will be used to assess the local presence of DNAPL pools at the top of the McNairy Formation. This sample also will be submitted for laboratory analysis to quantify the TCE concentration. If a significant thickness of pooled DNAPL is present at a soil boring site based on field observations, the boring will be terminated at the top of the McNairy Formation.

Although soil samples can be collected from the RGA, the coarse texture of the gravel makes recovery of residual DNAPL difficult; therefore, groundwater samples will be used to indicate the magnitude of RGA soil contamination. Up to 28 groundwater samples will be collected fkom the multi-port groundwater monitoring wells, which will be screened at the base of the UCRS gravel, through the RGA, and in the first upper McNairy sand to the total depth of approximately 34 m (110 ft). The specific intervals to be screened will be selected using the borehole geophysical log for boring 400-038. Groundwater will be analyzed for VOCs, radionuclides, metals, temperature, conductance, pH, Eh, dissolved oxygen, and major cations and anions.

Additional groundwater sampling will be performed during the operational phase of the treatability study. One groundwater sampling event will occur when SPH operations are approximately 80% complete (near calendar day 104). A second groundwater sampling event will occur when SPH operations are about 90% complete (near calendar day 117) and will help determine when to end SPH operation. Actual scheduling for the two operational groundwater sampling events will be based upon best estimates of progress of the system in removing the contaminants fiom the subsurface.

After the end of the soil heating operational period (before the soil and water has a chance to cool down), soil and groundwater samples will be collected again to evaluate the performance of the technology. Groundwater samples will be collected fkom the multi-port monitoring wells within one week after the heating phase of the treatability study is complete. Soil samples will be collected fiom nine borings drilled adjacent to the vacuum monitoring piezometers within two weeks of the completion of operational period. As with the baseline sampling, the soils will be analyzed for VOCs, radionuclides, metals, and soil moisture. Soil temperature profiles will be determined from the thermocouples on the

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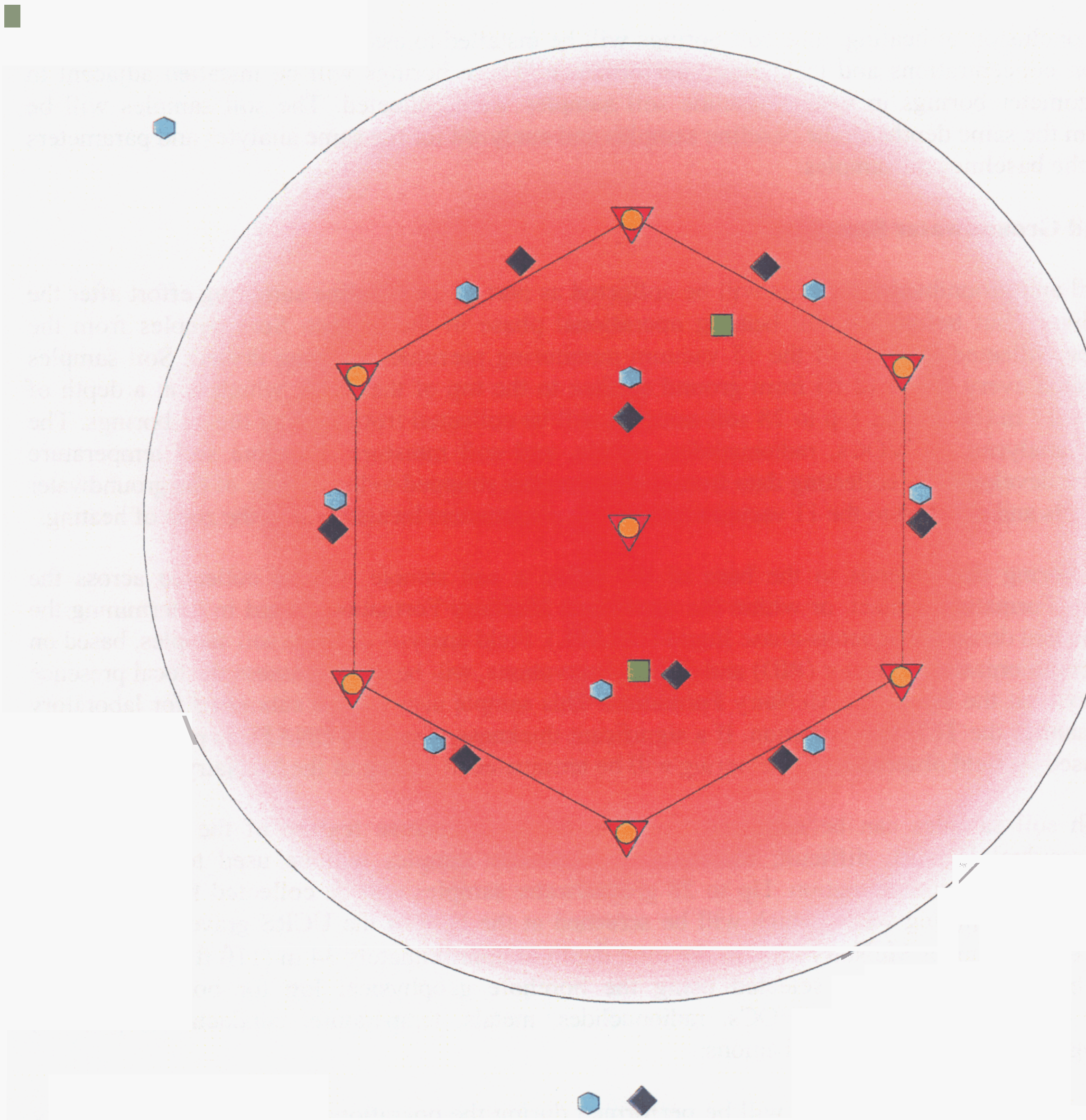

Note: Locations of borings and wells are conceptual and may change due to actual field conditions.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. A.2. General layout of test cell.

FIGURE No. cell.ppt
DATE 07-13-01

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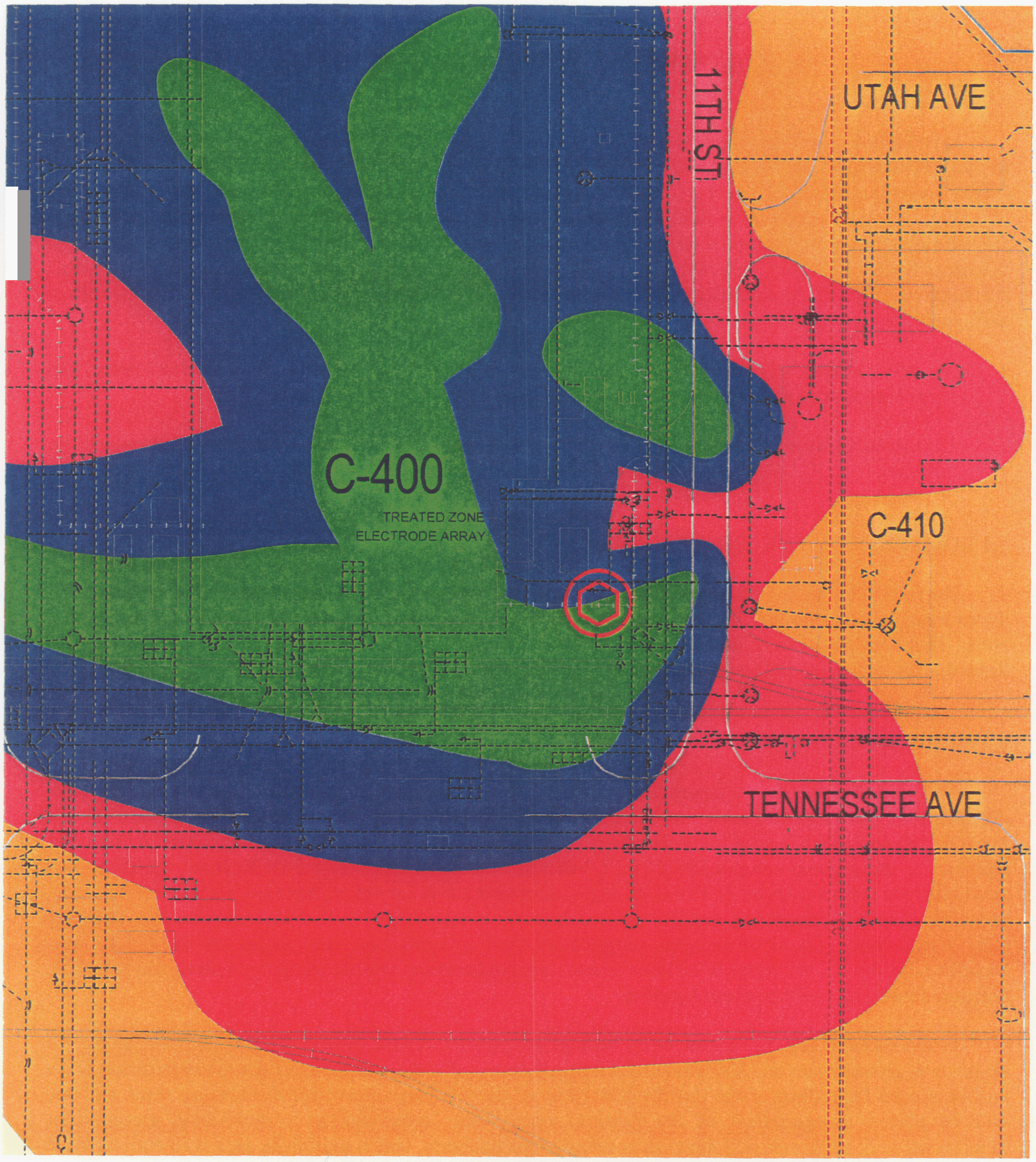

LEGEND:
FENCE LINE
ROAD
RAILROAD
UNDERGROUND UTILITY

TCE CONTOURS
> 100,000 ug/L
10,000 - 100,000 ug/L
1,000 - 10,000 ug/L
100 - 1,000 ug/L
5 - 100 ug/L

TREATED ZONE
ELECTRODE ARRAY

TRUE NORTH 20° PLANT NORTH

50 0 50 100 Feet

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee• Paducah, Kentucky• Portsmouth, Ohio

SAIC
Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. A.1. Approximate location of Six-Phase Heating Treatability Study.

FIGURE No. c5ac90001sk109.apr
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1. SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan (SAP) presents the basic strategies and procedures that will apply to soil, groundwater, and operational parameter sampling conducted in support of the Six-Phase Heating (SPH) Treatability Study (TS). This TS will demonstrate the constructability and measure the effectiveness of a single, SPH electrode array designed to vaporize and recover volatile organic compounds (VOCs) in the vadose and saturated zones of the upper continental deposits, also referred to as the Upper Continental Recharge System (UCRS), and in the saturated gravels of the lower continental deposits, also known as the Regional Gravel Aquifer (RGA). The primary focus of the sampling strategy will be to collect sufficient data to determine the following:

1. the effectiveness of SPH technology in reducing the concentration of VOCs in soils and groundwater, primarily trichloroethene (TCE); and

2. operational parameters for use in designing a full-scale system if the technology is shown to be effective.

1.1 LOCATION OF THE TREATABILITY STUDY

The SPH TS will be conducted at the southeast comer of the C-400 Building, in what appears to be the primary source area for the Northwest Plume. Figure A.1 shows the planned location for the TS test zone. This location was selected based on data collected during the Waste Area Group (WAG) 6 Remedial Investigation (RI) conducted in 1997 (DOE 1999).

1.2 SAMPLING STRATEGY

This section discusses the general sampling strategy to be followed to evaluate the test objective and document the performance goals presented in Section 3. The overall sampling strategy for the TS will focus on the soils of the upper continental deposits, as well as UCRS and RGA groundwater. Analytes of interest are the organic compounds TCE, 1,1-dichloroethene (DCE), *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride (also known as TCE and its degradation products), as well as benzene, carbon tetrachloride, and chloroform; radionuclides; metals; the geochemical parameters of pH, oxidation-reduction potential (Eh), conductance, dissolved oxygen, temperature, and soil moisture; and major anions and cations. Sampling for the TS will consist of three phases: pre-construction baseline sampling, operational sampling, and post-construction effectiveness sampling.

As indicated in Fig. A.2 a total of 35 borings are planned for the project. Four of the borings are for multi-level groundwater and soil temperature monitoring wells. One of the groundwater monitoring wells will be placed upgradient of the heating zone; two of these borings are within the heating zone; and one will be placed downgradient of the heating zone. When completed as a multi-level groundwater monitoring well, each well will have up to seven sampling ports, which will make each well equivalent to a multi-well cluster. The four wells together will result in up to 28 sampling points.

Seven borings for electrode and vapor recovery (VR) well installation also are planned. Six of the borings are in a roughly hexagonal arrangement with the remaining boring in the center of the pattern. The electrodes installed in these borings will heat the soil, and the associated VR wells will recover the vapor created by the heat. There also are 15 vacuum monitoring piezometers that will measure the amount of vacuum applied to the subsurface by the VR system, provide steam vents at the UCRS/RGA interface,

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groundwater monitoring wells and vacuum monitoring piezometers. Groundwater will be analyzed for VOCs, radionuclides, metals, temperature, conductance, pH, Eh, dissolved oxygen, and major cations and anions.

1.2.2 Operational Sampling

During the operation phase of the TS, several parameters will be measured to ensure optimum performance of the overall system and to determine the operating requirements and costs of the system. The parameters to be measured include the following.

- Energy usage will be recorded at the SPH power control unit (PCU) electrical meter to determine overall system energy requirements. Energy usage also will be recorded at the individual electrodes. The use of discrete electrically conductive intervals placed through the UCRS and the **RGA** formations will allow the energy input to each of these regions to be determined. Using the energy input, the steam production from each formation will be determined.

- Contaminant recovery, measured as the mass or volume of TCE recovered or the mass or volume of treatment residuals produced, will be monitored to assess the effectiveness of the system and to determine costs for contaminant removal. The mass of TCE will be determined by integrating vapor concentration measurements. This calculation can be cross-checked using the vapor treatment waste stream.

- Steam extraction rates and volume of condensate collected will be measured using a totalizer to track the progress of subsurface boiling and of energy input into the subsurface.

- Vacuum readings at the VR wellheads and the vacuum monitoring piezometers will provide information on how effectively the VR system is pulling vapor from the subsurface and its area of influence.

- Readings from thermocouples on the multi-port groundwater monitoring well casings and from the thermowells in the vapor monitoring piezometers will provide data on the soil heating profile as it develops.

- The VOC adsorption efficiency of the granular activated carbons **(GAC)** vapor treatment system will be monitored. GAC usage will be totalized and a % VOC loading will be obtained from the vendor prior to regeneration.

- Water addition at the electrodes will be recorded and addition rates and volumes calculated.

- The operating parameters of the system components, the **SPH** PCU, the condenser, the VR unit, and the vapor treatment system will be monitored so that maintenance, repairs, and adjustments can be accomplished to ensure optimum performance.

The recovery of contaminants from the subsurface will be evaluated by monitoring the extracted vapor and condensed liquid phase streams for flow rates and VOC concentrations. From this data, estimates of the rate of VOC removal and of the total mass of VOCs removed can be made. During operation of the SPH and VR systems, monitoring of the influent to the vapor-phase treatment system will include, at a minimum, all of the following.

- Twice weekly measurements of vacuum, flow rate by pitot tube, and VOC concentrations: VOC concentrations will be determined using a flame ionization detector (FID) or PID during twice weekly sampling. Measurements will be made downstream of the condenser.

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- Weekly collection of Summa canister samples for detailed VOC constituent analysis: Summa canisters will be equipped to provide a 24-hour integrated sample.

- Monitoring at the discharge from the **SPH** condenser will include, at a minimum, totalizing condensate production and scheduled collection of condensate samples for laboratory analysis.

The VOC adsorption efficiency of the vapor phase treatment system will be determined by measuring VOC concentrations at the inlet of the primary GAC vessel, at the inlet of the secondary GAC vessel, and at the discharge stack. During operation of the **SPH** and VR systems, minimum monitoring of the GAC vapor-phase treatment unit will include the following:

- Twice weekly measurements of total VOC concentrations at the locations described above using a PID or FID; and

- Weekly collection and analysis of Summa canister samples at the outlet of the unit for detailed VOC constituent analysis.

1.2.3 Health and Safety Sampling

During the boring and well installation phases and the treatment phase of the project a very small potential for exposure to TCE exists for site workers. While there is little potential for overexposure to TCE real-time monitoring with alarming instruments and personnel sampling will be used to document that exposure levels were maintained well below the 50 parts per million (ppm) for an 8-hour time-weighted average (TWA) permissible exposure limit.

Site sampling for the potential exposure to TCE will be conducted for 2 days before any subsurface material is brought to the surface to establish baseline conditions at the work site. The sampling will be conducted following National Institute for Occupational Safety and Health method 1022 using sampling pumps and charcoal sorbent tubes.

Monitoring of the worker breathing zone will be conducted using an alarming direct-reading PID. Readings will be taken continuously while subsurface material is being brought to the surface. The PID will be calibrated before each day of use with a standard calibration gas, typically 100 ppm isobutylene, and at the end of each day following the manufacturer's operating instructions. These calibration readings and the field readings will be entered into a monitoring logbook. In addition, personnel sampling pumps will be used 10 days per month on personnel most likely to receive exposure.

During heating operations, real-time monitoring of stack exhaust for TCE will be conducted using a fixed industrial PID monitor. This instrument will have an alarming capability and will be set to alarm at 25 ppm. In addition, two area PID monitors will be set up to monitor the ambient air conditions. These monitors will be checked per the manufacturer's instructions, and the TWA will be recorded daily. These PIDs also will be calibrated each day of use. Appendix C discusses all health and safety monitoring in greater detail.

1.2.4 Waste Management Sampling

The SAIC Waste Coordinator will be responsible for sampling the solid and liquid IDW as needed. During sampling, all appropriate health and safety concerns will be addressed. Sample materials from different containers will not be mixed, and only containers requiring further characterization will be sampled. Table **A.**1 summarizes waste characterization requirements. The sampling procedures for waste characterization are described in detail in the Waste Management Plan (WMP) in Appendix D.

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Table A.1. Summary of IDW sampling and analysis for the Six-Phase TS

Waste Stream	Volume	Sample Requirements	Solid	Liquid	Analytical Requirements
SOLIDS	**(Drums)**				
Drill cuttings	280 (4 roll-offs)	[a]5 (one 5-point composite sample per roll-off)	4	N/A	Exhibit "E" Tables 1.1, 1.2, and 1.3 of the RAAS Contract.
PPE and plastic	31	None	NA	NA	Based on associated drill cuttings analytical data
Excess TS process media	11	None	NA	NA	Process knowledge
Misc. non-contaminated construction waste	5	None	NA	NA	Process knowledge
Decontamination sludge	2	1/drum	2	N/A	Tables 1.2 and 1.3 **of** "Exhibit E" **of** the RAAS Contract
GAC	17 20,000 lbs containers	2 composites per container	34	N/A	Table 1.2 **of** Exhibit "E" of the RAAS Contract.
LIQUIDS	**(Gals)**				
Monitoring well development	14,000	1/1,200 gal	N/A	12/ 1	12-Oil, grease, & polychlorinated biphenyls (PCBs) only. 1-Table 1.4 **of** "Exhibit E" **of** the RAAS Contract
Decontamination water	1,900	1/1,200 gal	N/A	2/ 1	2-Oil, grease, & PCBs only. 1-Table 1.4 of "Exhibit E" **of** the RAAS Contract
QA/QC SAMPLES					
Field equipment blanks	N/A	1/20 samples	N/A		Table 1.4 **of** "Exhibit E" **of** the **RAAS** Contract
Trip blanks	N/A	[b]	N/A	7	VOCs
Field duplicates	N/A	[c]	9	1	Same as original sample
TOTAL			178	15	

[a]If field radiological surveys dictate, drums of drill cuttings will be emptied into **20** yd^3 roll-offs. Each roll-off will be sampled **by** collecting one 5-point composite sample from each roll-off for complete analysis.
[b]One trip blank per shipment container with VOC sample material.
[c]One field duplicate for every **20** samples per waste matrix (i.e., solids and liquids). If debris waste were to be sampled, it would need a separate field duplicate than the one for solids because the collection method would differ.

1.2.5 Analytical Requirements

During the TS, a fixed-base laboratory contracted through the Sample Management Office will perform most analyses. Specific analytical methods and procedures are described in the Quality Assurance

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Project Plan (QAPP) contained in Appendix **B of** the ***Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,*** DOE/OR/07-1889&D2 (DOE 2001a). Certain parameters, such as pH, dissolved oxygen, temperature, and conductance, will be measured in the field using appropriate field instruments such as field test kits and in-line flow cells. The procedures covering these field measurements are listed in Table **A.3.** In addition, an on-line analyzer will be used to monitor VOC emissions from the system. Work guides for its operation will be developed as part of an operations and maintenance plan.

Waste characterization sampling will be conducted during the installation and operation of the SPH system. Waste characterization requirements are discussed in detail in the WMP, Appendix D.

1.2.6 Sampling Schedule

Two soil sampling events are planned during the treatability study. One sampling event will precede the installation of the SPH system to establish baseline conditions. The second soil sampling event will occur within two weeks after the heating phase of the treatability study is complete.

Four groundwater sampling events are planned during the treatability study. The first sampling event will establish baseline conditions prior to SPH operation. The second groundwater sampling event will occur when SPH operations are about 80% complete (near calendar day 104). The third groundwater sampling event will occur when SPH operations are about 90% complete (near calendar day 117) and will help to determine when to end SPH operation. The fourth groundwater sampling event will occur within one week after the heating phase of the treatability study is complete. Actual scheduling for the two interim groundwater sampling events will be based upon best estimates of progress of the system in removing contaminants from the subsurface.

Sampling and monitoring of the operating system will be ongoing throughout the treatability study. Typical sampling and monitoring events, the number **of** points sampled or monitored per event, and the methods and schedules used are summarized in Table **A.2.**

1.3 SAMPLING PROCEDURES

All sampling at the Paducah Gaseous Diffusion Plant (PGDP) will be conducted in accordance with approved medium-specific procedures consistent with ***U.S. Environmental Protection Agency (EPA), Region IV, Standard Operating Procedures*** (EPA 1996). Any deviations from these procedures will be approved by PGDP Environmental Management Enrichment Facilities Program (EMEF) and documented on a Field Change Request form as detailed in the QAPP. Table **A.3** provides a list of the procedures applicable to fieldwork that will provide procedural guidance for the SPH TS.

The procedures addressing monitoring well installation and groundwater sampling will require project-specific changes or the development of operator aids to accommodate the installation and sampling of multi-port monitoring wells.

Table A.2. SPH system measurement and sampling schedule

Measurement or sampling event	Points	Method	Minimum frequency (See *"Notes"* below)	Measurement objective & reporting units
Vacuum:				
Vadose zone	45	Digital manometer	1	Verify vadose zone vacuum – in. H_2O
VR wellheads	14	Vacuum gauge	1	VR system performance – in. Hg
Steam vent heads	22	Vacuum gauge	1	General systems operations data – in. Hg
Before condenser	1	Vacuum gauge	1	General systems operations data – in. Hg
After condenser	1	Vacuum gauge	1,2,3	VOC removal rates and totals – in. Hg
After VR blower	1	Digital manometer	1,2	General systems operations data – in. H_2O
After heat exchanger	1	Digital manometer	1	General systems operations data – in. H_2O
Pressure:				
Condenser pump	1	Pressure gauge	1,2	System operations check – psi
Temperature:				
Subsurface -wells	38	Type T thermocouple	5	Track remediation performance – "C
Subsurface -piezometers	15	Type T thermocouple	8	Track remediation performance – °C
VR wellheads	14	Type T thermocouple	8	Track remediation performance – °C
Condenser inlet	1	Type T thermocouple	5	Track remediation performance – "C
After condenser	1	Temperature gauge	1,2	Systems operations check – °C
After VR blower	1	Temperature gauge	1,2	Systems operations check – "C
After heat exchanger	1	Temperature gauge	1	Systems operations check – "C
After primary GAC	1	Temperature gauge	1	Systems operations check – "C
Air & Vapor Flow:				
VR wellheads	14	Pitot Tube	1	VR system performance – approximate scfm
After condenser	1	Pitot Tube	1,2,3	VOC removal rate – scfm
After dilution blower	I	Pitot Tube	1,2,4	Operations & treatment efficiency – scfm
Water Flow:				
Condenser makeup	1	Calibrated flow meter	5	Volume of water used – gpm
Waste discharge	1	Calibrated flow meter	5	Volume of condensate – gpm
VOC Sampling:				
VR wellheads	14	Tedlar or Summa	6	VOC removal rate and totals – mg/L
After condenser	I	FID and Summa	7	VOC removal rate and totals – mg/L
After vapor treatment unit	1	FID and Summa	7	Abatement system efficiency – mg/L
Wastewater discharee	1	VOA vial	7	Wastewater VOC concentrations – mg/L

Notes:

1. Upon system startup, then weekly to ensure that baseline readings have not significantly changed.
2. When sampling for VOC concentrations.
3. When performing sampling for inlet VOC concentrations.
4. When performing sampling for vapor treatment system efficiency.
5. Continuous.
6. No VR wellhead samples are presently planned.
7. Per the sampling schedule of the Wastewater Discharge Authorization.
8. Weekly readings at various depths from the piezometer thermowells.

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Table A.3. Field operations procedures

Procedure No.	Procedure Title
FTP-1215	Use of Field Logbooks
RAAS-024	Lithologic Logging
FTP-650	Labeling, Packaging, and Shipping of Environmental Field Samples
FTP-370	Groundwater Sampling Procedures: Water Level Measurements
RAAS-001	Monitoring Well Purging and Groundwater Sampling
RAAS-013	Filter Pack and Screen Selection for Wells and Piezometers
RAAS-027	Monitoring Well Installation
RAAS-026	Monitoring Well Development
FTP-880	Field Measurement Procedures: pH, Temperature, and Conductivity
FTP-955	Field Measurement Procedures: Dissolved Oxygen
FTP-755	Field Gas Chromatograph Headspace Screening for Volatile Organic Compounds
RAAS-016	Sampling of Containerized Wastes
RAAS-017	Opening Containerized Waste
MAS-008	On-site Handling and Disposal of Waste Materials
RAAS-007	Identification and Management of Waste Not From A Radioactive Material Management Area
RAAS-002	Paducah Contractor Records Management Program
RAAS-005	Quality Assured Data
FTP-625	Chain-of-Custody
FTP-1200	Field Quality Control
RAAS-006	Data Management Coordination
FTP-400	Equipment Decontamination
RAAS-014	Off-site Decontamination Pad Operating Procedures
FTP-405	Cleaning and Decontaminating Sample Containers and Sampling Equipment
RAAS-010	Environmental Radiological Screening
RAAS-011	Pumping Liquid Wastes into Tankers
TP-DM-300-5	Receiving and Reviewing Data Packages
TP-DM-300-10	Analytical Laboratory Interface
TP-DM-300-13	Tracking Analytical Data
FTP-525	Subsurface Soil Sampling
RAAS-004	Archival of Environmental Data Within the ER Program
TP-DM-300-2	Data Entry
TP-DM-300-7	Data Validation

1.3.1 Monitoring Well Installation and Development

Monitoring wells installed during implementation of the **TS** will be capable of monitoring up to seven discrete intervals within one well. All wells will be installed as single-cased stainless steel monitoring wells of sufficient diameter to accommodate the multi-port sampling system. Intervals to be screened will include one interval in the UCRS, five intervals in the RGA, and one interval in the underlying McNairy Formation. Specific intervals to be monitored will be selected using existing lithologic and geophysical logs from the WAG 6 RI. Design of the groundwater monitoring wells is included in the *90% Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (SPH Design Package) (DOE 2001b).

Monitoring wells installed during the TS will be developed prior to installation of the multi-port sampling system. The wells will be developed in accordance with recommendations from the sampling system manufacturer. Development criteria will be consistent with procedures. Groundwater quality will be monitored during development for the parameters of pH, conductance, and turbidity. Development will continue until (1) pH stabilizes to within 0.10 units, (2) conductance stabilizes to within 10 μmhos/cm, and **(3)** turbidity is

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below **10** nephelometric turbidity units (NTU). Any modifications to acceptable criteria will be approved by the Management and Integration (M&I) Contractor Subcontract Technical Representative (STR).

After installation of the monitoring wells, a dedicated multi-port sampling system will be installed in each well in accordance with manufacturer specifications.

Wells and borings, not required for effectiveness monitoring, could be potential pathways for the vertical migration of contaminants. To minimize the impact of these penetrations, all boreholes will be properly abandoned including grouting the boreholes with high solids bentonite grout. No uncased boring will be allowed to stand open overnight.

1.3.2 Groundwater Sampling

Groundwater sampling will be conducted in accordance with the following procedures:

- FTP-370, Groundwater Sampling Procedures: Water Level Measurements;
- **RAAS-00**1, Monitoring Well Purging and Groundwater Sampling;
- FTP-880, Field Measurement Procedures: pH, Temperature, and Conductivity; and
- FTP-955, Field Measurement Procedures: Dissolved Oxygen.

A procedure or work guide for field measurement of Eh will be developed using manufacturer's recommendations for the equipment to be used in the field.

1.3.3 Subsurface Soil Sampling

Subsurface soil sampling will be conducted in accordance with procedure FTP-525, "Subsurface Soil Sampling." Soils will be collected continuously and samples collected for analysis from each 2-ft core. The baseline sampling will be done as the borings for 11 of the 15 vacuum monitoring piezometers are drilled. Post-test characterization samples will be collected from selected adjacent borings.

1.4 DOCUMENTATION

Field documentation will be maintained throughout the TS in various types of documents and formats, including the site logbook, field logbooks, sample labels, sample tags, chain-of-custody forms, and field data sheets. The following general guidelines for maintaining field documentation will be implemented.

- All entries will be written clearly and legibly using indelible black ink.

- Corrections will be made by striking through the error with a single line that does not obliterate the original entry. Corrections will be dated and initialed.

- Dates and times will be recorded using the format "mm/dd/yy" for the date and the military (i.e., 24-hr) clock to record the time.

- Zeroes will be recorded with a slash (/) to distinguish them from letter Os.

- Blank lines are prohibited. Information should be recorded on each line or the line should be lined out, initialed, and dated.

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- No documents will be altered, destroyed, or discarded even if they are illegible or contain inaccuracies that require correction.

- All information blocks on field data forms will be completed or a line will be drawn through the unused section, and the area will be dated and initialed.

- Unused logbook pages will be marked with a diagonal line drawn from corner to corner and a signature and date must be placed on the line.

- Security of all logbooks will be maintained by storing them in a secured (e.g., locked) area when not in use.

- Photocopies of all logbooks, field data sheets, and chain-of-custody forms will be made weekly and sent to the project file.

1.4.1 Field Logbooks

Field team personnel will use bound field logbooks with sequentially numbered pages for the maintenance of field records and for documenting any information pertinent to field activities. Field forms will be numbered sequentially or otherwise controlled. A designated field team member will record sampling activities and information from site exploration and observation in the field logbook. Field documentation will conform to procedure FTP-1215, "Use of Field Logbooks."

An integral component of Quality Assurance/Quality Control (QA/QC) for the field activities will be the maintenance of accurate and complete field records and the collection of appropriate field data forms. The primary purpose of the logbook is to document each day's field activities; the personnel on each sampling team; and any administrative occurrences, conditions, or activities that may have affected the fieldwork or data quality of any environmental samples for any given day. The level of detail of the information recorded in the field logbook should be such that an accurate reconstruction of the field events can be created from the logbook. The project name, logbook number, client, contract number, task number, document control number, activity or site name, and the start and finish dates will be listed on each logbook's front cover. Important phone numbers, radio call numbers, emergency contacts, and a return address should be recorded on the inside of the front cover.

1.4.2 Sample Log Sheets

A sample log sheet will contain sample-specific information for each field sample collected, including field QC samples. Generally, sample log sheets will be preprinted from the data management system with the following information:

- name of sampler;
- project name and number;
- sample identification number;
- sampling location, station code, and description;
- sample medium or media;
- sample collection date;
- sample collection device;
- sample visual description;
- collection procedure;
- sample type;

- analysis; and
- preservative.

In addition, all specific analytical requests will be preprinted from the data management system and will include the following for each analytical request:

- analysis/method,
- container type,
- number of containers,
- container volume,
- preservative (type/volume), and
- destination laboratory.

During sample collection, a field team member will record the remaining required information and will sign and date each sample log sheet. The following information will be recorded for each sample:

- whether or not the sample was collected;
- the date and time of collection;
- the name of the collector;
- collection methods and/or procedures;
- all required field measurements and measurement units;
- instrumentation documentation, including the date of last calibration;
- adherence to or deviation from the procedure and the *SAP;*
- weather conditions at the time of sample collection;
- activities in the area that could impact subsequent data evaluation;
- general field observations that could assist in subsequent data evaluation;
- lot number of the sample containers used during sample collection;
- sample documentation and transportation information, including unique chain-of-custody form number, air bill number, and container lot number; and
- all relevant and associated field **QC** samples (for each sample).

If preprinted sample log sheets are not used, all information will be recorded manually. **A** member of the field sampling team (other than the recorder) will perform a **QA** review of each sample log sheet and document the review by signing and dating the log sheet. Notations of deviations will be initialed by the Field Task Manager (FTM) as part of his/her review of the logbook.

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1.4.3 Field Data Sheets

Field data sheets will be maintained, as appropriate, for the following types of data:

- water level measurements,
- soil boring logs,
- monitoring well construction logs,
- sample log sheets,
- well development logs,
- well purging logs,
- groundwater sampling logs,
- chains of custody,
- instrument calibration logs, and
- temperature monitoring sheets.

Data to be recorded will include such infomation as the location, sampling depth, sampling station, and applicable sample analysis to be conducted. Field-generated data forms will be prepared, if necessary, based on the appropriate requirements. The same information may be included in the field logbook or, if not, the field logbook should reference the field data sheet.

1.4.4 Sample Identification, Numbering, and Labeling

In addition to field logbooks and field data sheets, the sampling team will use labels to track sample holding times, ensure sample traceability, and initiate the chain-of-custody record for the environmental samples. **A** pressure-sensitive gummed label will be secured to each sample container at the time of collection, including duplicates and trip or field blanks, at or before the completion of collection of that sample. Sample labels will be waterproof or will be sealed to the sample container with clear acetate tape after all information has been written on the label. Generally, sample labels will be preprinted with information from the data management system and will contain the following information:

- station name,
- sample identification number,
- sample matrix,
- sample type (grab or composite),
- type or types of analysis required,
- sample preservation (if required), and
- destination laboratory.

A field sampling team member will complete the remaining information during sample collection including these items:

- date and time of collection, and
- initials of sampler.

The sample numbers will be recorded in the field logbook along with the time of collection and descriptive information previously discussed.

The sample identification plan is outlined in the procedure FTP-650, “Labeling, Packaging, and Shipping of Environmental Field Samples.”

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1.4.5 Sample Chain of Custody

Chain-of-custody procedures will document sample possession from the time of collection, through all transfers of custody, to receipt at the laboratory and subsequent analysis. Chain-of-custody records will accompany each packaged lot of samples; the laboratory will not analyze samples that are not accompanied by a correctly prepared chain-of-custody record. **A** sample will be considered under custody if it is **(1)** in the possession of the sampling team, (2) in view of the sampling team, or **(3)** transferred to a secured (i.e., locked) location.

Chain-of-custody records will follow the requirements as specified in the procedure FTP-625, "Chain-of-custody." This form will be used to collect and track samples from collection until transfer to the laboratory. Copies of the signed COCs will be faxed or delivered to the Bechtel Jacobs Company LLC Sample Management Office within **3** days of sample delivery.

The Sampling Team Leader is responsible for reviewing and ensuring the accuracy and completeness of the chain-of-custody form and for the custody of samples in the field until they have been properly transferred to the Sample Coordinator. He or she is responsible for sample custody until the samples are properly packaged, documented, and released to a courier or directly to the analytical laboratory. If samples are not immediately transported to the analytical laboratory, they will remain in the custody of the Sample Coordinator where they will be refrigerated and secured either by locking the refrigerator or by placing custody seals on the individual containers.

Each chain-of-custody form will be identified by a unique number located in the upper-right comer, recorded on the sample log sheet at the time of sample collection. The laboratory chain-of-custody will be the "official" custody record for the samples. Each chain-of-custody form will contain the following information:

- the sample identification for each sample;
- collection data for each sample;
- number of containers of each sample;
- description of each sample (i.e., environmental matrix/field QC type);
- analyses required for each sample; and
- blocks to be signed as custody is transferred from one individual to another.

The airbill number will be recorded on the chain-of-custody form if applicable. The laboratory chain-of-custody form will be sealed in a resealable plastic bag and taped to the inside of the cooler lid if the samples are to be shipped off-site. **A** copy will be retained in the laboratory, and the original will be returned to the M&I Sample Manager with the completed data packages.

.At each point of transfer, the individuals relinquishing and receiving custody of the samples will sign in the appropriate blocks and record the date and time of transfer. When the laboratory sample custodian receives the samples, he or she will document receipt of the samples, record the time and date of receipt, and note the condition of the samples (e.g., cooler temperature, whether the seals are intact) in the comments section. The laboratory then will forward appropriate information to the M&I Sample Manager. This information may include the following:

- a cover memo stating sample receipt date and any problems noted at the time of receipt; and

- a report showing the field sample identification number, the laboratory identification number, and the analyses scheduled by the laboratory for each sample.

1.4.6 Sample Shipment

Aliquots of investigative samples will be screened by an on-site laboratory before shipment to an off-site laboratory. Results from the screening process will be recorded in Paducah PEMS and reviewed prior to preparation for sample shipment offsite. Sample containers will be placed in the shipping container and packed with ice and absorbent packing for liquids or with bubble wrap packing for solids. The completed chain-of-custody form will be placed inside the shipping container unless otherwise noted. The container then will be sealed. In general, sample containers will be packed according to the following procedures.

- Glass sample containers will be wrapped in plastic insulating material to prevent contact with other sample containers or the inner walls of the container.

- Logbook entries, sample tags and labels, and chain-of-custody forms will be completed with sample data collection information and names of all persons handling the sample in the field before packaging.

- Samples, temperature blanks, and trip blanks will be placed in a thermally insulated cooler along with ice packed in resealable plastic bags. After the cooler is filled, the appropriate chain-of-custody form will be placed in the cooler in a resealable plastic bag attached to the inside of the cooler lid.

- Samples will be classified according to U.S. Department of Transportation (DOT) regulations pursuant to 49 CFR 173. All samples will be screened for radioactivity to ensure that DOT limits of **2.0** nCi/ml of liquid waste and **2.0** nCi/g for solid waste are not exceeded.

1.4.7 Field Planning Meeting

A field-planning meeting will occur before work begins at the site ***so*** that all involved personnel will be informed of the requirements of the fieldwork associated with the project. Additional planning meetings will be held whenever new personnel join the field team or if the scope of work changes significantly. Each meeting will have a written agenda and attendees must sign **an** attendance sheet, which will be maintained onsite and in the project files. The following topics will be discussed at these meetings:

- project- and site-specific health and safety,
- objectives and scope of the fieldwork,
- equipment and training requirements,
- procedures,
- required QC measures, and
- documents covering on-site fieldwork.

1.4.8 Readiness Checklist

Before implementation of the field program, M&I personnel will review the work control documents to identify all field activities and materials required to complete the activities, including:

- task deliverables,
- required approvals and permits,
- personnel availability,
- training,
- field equipment,
- sampling equipment,

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- site facilities and equipment, and
- health and safety equipment.

Before fieldwork begins, appropriate M&I EMEF personnel will concur that readiness has been achieved.

1.5 DECONTAMINATION PROCEDURES

Decontamination of all sampling equipment will be in accordance with procedure FTP-400, "Decontamination of Field Equipment." Decontamination of drilling-related equipment will be conducted in accordance with procedure FTP-400, "Equipment Decontamination." Decontamination of pumps, bladders, or other downhole sampling equipment such as Teflon@tubing is per RAAS-015, "Decontamination of Sampling Containers and Sampling Devices."

Personal protective equipment, clothing, and decontamination procedures for the implementation of the Treatability Study Work Plan (TSWP) are addressed in the Environmental, Safety, and Health Plan (ES&HP) contained in Appendix C of the TSWP (DOE 2001a).

1.6 WASTE MANAGEMENT PROCEDURES

The following PGDP EMEF waste management procedures will be used during the implementation of the TSWP:

- RAAS-014, Off-site Decontamination Pad Operating Procedures;
- RAAS-011, Pumping Liquid Wastes into Tankers;
- RAAS-016, Sampling of Containerized Waste; and
- RAAS-017, Opening Containerized Waste.

A detailed description of waste management procedures is presented in the project-specific WMP contained in Appendix D of the TSWP (DOE 2001a).

1.7 PROCEDURES FOR SAMPLE ANALYSES

All laboratories performing analyses for the TS will be DOE-regulated or be required to hold a current Nuclear Regulatory Commission or Agreement State License for handling radioactive materials. In addition, all laboratories will be audited and accepted by the DOE-Oak Ridge Sample Management Office before mobilization for fieldwork.

When available and appropriate for the sample matrix, SW-846 methods will be used. When SW-846 methods are not available or not appropriate, other nationally recognized methods such as DOE, EPA, and American Society for Testing and Materials methods will be used.

Radiological Analysis Procedures

The following standardized procedure manuals are recommended references for radiological analysis:

- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA 1980);

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- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846 (EPA 1986);

- Eastern Environmental Radiation Facility, *Radiochemistry Procedures Manual,* EPA 5201 5-84-006, (EPA 1984); and

- *Environmental Measurements Laboratory Procedures Manual,* HASL-300 (DOE 1982).

All groundwater samples will be analyzed for radionuclides. Analytical methods, method detection limits, sample container requirements, and sample preservation requirements for all environmental and waste characterization sampling required during this treatability study are addressed in the QAPP.

1.8 SAMPLE LOCATION SURVEYING

Surveying of sampling locations will be conducted upon completion of SPH installation activities. Where possible, permanent markers consisting of flagging or of wooden or metal stakes will be used to mark all boring locations. Brass markers will be incorporated as part of pad installation for all monitoring wells. However, a thorough description of each location will be made during field sampling activities and documented using field maps. This documentation will be used for the survey effort if permanent sampling location markers are disturbed or if permanent markers cannot be placed at the time of sampling. A member of the field sampling crew will accompany the survey crew to provide information regarding the location of sampling points. Each sample point will be surveyed for its horizontal and vertical location using the PGDP coordinate system for horizontal control. Additionally, State Plane Coordinates will be provided using the U.S. Coast and Geodetic Survey North American Datum of 1983. The datum for vertical control will be the U.S. Coast and Geodetic Survey North American Vertical Datum of 1988. Accuracy for this work will be that of a Class 1 First Order survey. Work will be performed by or under responsible charge of a Professional Land Surveyor Registered in the Commonwealth of Kentucky. All coordinates will be entered into Paducah PEMS and transferred with the stations ready-to-load file to Paducah OREIS.

2. REFERENCES

DOE 1999. *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1727&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 2001a. *Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1889&D2, August.

DOE 2001b. *90% Design Drawings and Technical Specifications Package for the Six-Phase Heating Treatability Study for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1921&D1/R1, U.S. Department of Energy, Paducah, KY, August.

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APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
FOR
SIX-PHASE HEATING TREATABILITY STUDY WORK PLAN

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CONTENTS

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CONTENTS (continued)

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FIGURES

TABLES

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ACRONYMS

ASTM	American Society of Testing and Materials
BJC	Bechtel Jacobs Company LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DQO	Data Quality Objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
FCRF	Field Change Request Form
FS	Feasibility Study
FTM	Field Task Manager
KDEP	Kentucky Department for Environmental Protection
MDL	method detection limits
M&I	management and integration
MS	matrix spike
MSD	M/S matrix spike duplicate
OREIS	Oak Ridge Environmental Information System
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PEMS	Project Environmental Management System
PGDP	Paducah Gaseous Diffusion Plant
pH	logarithm of the hydrogen-ion concentration
QA	quality assurance
QAPP	Quality Assurance Control Plan
QC	quality control
RAAS	Remedial Action Assessment Contract
SAP	Sampling and Analysis Plan
SOP	standard operating procedures
SPH	Six-Phase Heating
STR	Subcontract Technical Representative
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TS	treatability study
TSWP	Treatability Study Work Plan
VOC	volatile organic compound
WMP	Waste Management Plan

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QUALITY ASSURANCE PROJECT PLAN

Project Title: SIX-PHASE HEATING TREATABILITY STUDY

Approved By: Glen Cowart Date: 8/30/2001

Glen Cowart
Science Applications International Corporation
Quality Assurance Manager

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QAMS-005 and QA/R-5 LOCATOR PAGE

QAMS-005/80	QA/R-5	Section Number and title in Quality Assurance Plan
1.0 Title Page with Provision for Approval Signatures	A1 Title Page and Approval Sheet	Approval Page
2.0 Table of Contents	A2 Table of Contents	Contents
3.0 Project Description	A5 Project Definition/Background A6 Project/Task Description	1 Project Description
4.0 Project Organization and Responsibility	A3 Distribution List A4 Project/Task Organization A8 Special Training/Certification A9 Documents and Records	2 Project QA Responsibility 15 Qualifications and Training of Personnel 17 Document Control and Records Management
5.0 QA Objectives for Measurement (PARCC)	A7 Quality Objectives and Criteria	3 QA Objectives for Measurement of Data
6.0 Sampling Procedures	B1 Sampling Process Design B2 Sampling Methods	4 Sampling Procedures
7.0 Sample Custody	B3 Sample Handling and Custody	5 Sample Custody
8.0 Calibration Procedures and Frequency	B7 Instrument/Equipment Calibration and Frequency	6 Calibration Procedures and Frequency
9.0 Analytical Procedures	B4 Analytical Methods	7 Analytical Procedures
10.0 Data Reduction, Validation, and Reporting	D1 Data Review, Verification, and Validation D2 Verification and Validation Methods B9 Non-direct Measurements B10 Data Management	8 Data Review and Reporting
11.0 Internal Quality Control Checks and Frequency	B5 Quality Control	9 Internal Quality Control Checks
12.0 Performance and Systems	C1 Assessment and Response Actions	10 Auditsand Surveillances
13.0 Preventative Maintenance	B6 Instrument/Equipment Testing, Inspection, and Maintenance	11 Preventive Maintenance
14.0 Specific Routine Procedures Measurement Parameters Involved	D3 Reconciliation with User Requirements	12 Specific Routine Procedures to Assess Data Precision, Accuracy, and Completeness
15.0 Corrective Action	C1 Assessment and Response Actions	13 Nonconformances and Corrective Action Procedures
16.0 QA Reports to Management	C2 Reports to Management	14 QA Reports to Management
		16 Field Changes

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10 CFR 830.120 LOCATOR PAGE

The following 10 quality assurance **(QA)** elements are discussed in 10 CFR 830.120. This locator is a crosswalk between those 10 elements and the related sections of the governing **QA** documents for the Six-Phase Heating (SPH) Treatability Study (TS).

10 CFR 830.120 Element	SPH Treatability Study Work Plan Project Reference
1. Management (i) Program	*Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 2)
1. Management (ii) Personnel Training and Qualification	*SPH Treatability Study QAPP* (Section 10) and *Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 5)
1. Management (iii) Quality Improvement	*SPH Treatability Study QAPP* (Section 13) and *Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section **4)**
1. Management (iv) Documents and Records	*SPH Treatability Study QAPP* (Section 17) and *Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 5)
2. Performance (i) Work Processes	*SPH Treatability Study QAPP* (Section 6), Remedial Action Assessment Subcontract Procedures, and *Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 6)
2. Performance (ii) Design	*SPH Treatability Study Work Plan* (Section **4)** and *Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 7)
2. Performance (iii) Procurement	*Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 8)
2. Performance (iv) inspection and Acceptance Testing	*Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 9)
3. Assessment (i) Management Assessment	*Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 10)
3. Assessment (ii) Independent Assessment	*Quality Assurance Project Plan* ***for*** *Paducah Remedial Action Assessment Subcontract* (Section 11)

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1. PROJECT DESCRIPTION

Work on this assignment will be performed in accordance with the ***Quality Assurance Project Plan for Paducah Remedial Action Assessment Subcontract*** (SAIC, February 2000). This Quality Assurance Project Plan (QAPP) has been prepared in accordance with QAMS-005/80 (EPA **1983);** 10 CFR **830.120;** and ***Standard Operating Procedures and Quality Assurance Manual*** (EPA 1991a). In addition, a crosswalk table has been provided that shows the relationship to EPA QA/G5 ***EPA Guidance for Quality Assurance Project Plans,*** **EPA/600/R-98/018,** February 1998. This QAPP has been reviewed for Quality Assurance/Quality Control (QA/QC) requirements by the U.S. Department of Energy (DOE) Management and Integration (M&I) Contractor QA Specialist, who will maintain QA oversight throughout the project.

The following field forms and field QC requirements are provided or described within the text of this QAPP:

- QA objectives for field measurements,
- field sampling requirements for laboratory analyses,
- field instrument calibration and preventive maintenance procedures,
- field equipment and calibration check frequencies,
- Calibration Log Form,
- field QC samples,
- Nonconformance Report Form, and
- Field Change Request Form (FCRF).

2. PROJECT QA RESPONSIBILITY

Adherence to the QA/QC requirements in this QAPP will require coordination and integration between QA representatives from M&I Contractor and the Remedial Action Assessment Subcontract (RAAS) Contractor. The roles and responsibilities for QA representatives from both organizations are outlined in Table 14.1 of the Six-Phase Heating Treatability Study Work Plan (TSWP). The RAAS Contractor's QA Coordinator will assume responsibility for day-to-day QA activities associated with the project and all QA issues related to the RAAS Contractor's QA program. The **RAAS** Contractor's QA Manager also will be responsible for all coordination with the M&I Contractor QA Specialist. The M&I Contractor QA Specialist will provide QA oversight and coordination with DOE and the regulatory agencies on all QA issues.

Each project team member is responsible for notifying the Field Task Manager (FTM), the Project Manager, the QA staff, or other responsible persons if he/she discovers a condition that may affect the quality of the work being performed. The following staff members have specific corrective action responsibilities.

- **RAAS** Contractor Site Manager — Overall responsibility for implementing corrective actions.

- **RAAS** Contractor Quality Manager — Overall responsibility for tracking and accepting corrective actions.

- **RAAS** Contractor Project Manager — Implementing task-specific corrective actions.

- **RAAS** Contractor FTM — Identifying and implementing corrective actions during field activities. Notifying the Project Manager and **QA** staff of conditions not immediately corrected.

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3. QA OBJECTIVES FOR MEASUREMENT OF DATA

3.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problems being investigated. DQOs also establish numeric limits to ensure that data collected are of sufficient quality and quantity for user applications.

3.2 DATA CATEGORIES

Two descriptive data categories have been specified by the **U.S.** Environmental Protection Agency (EPA) in ***Data Quality Objectives Process for Superfund,*** Interim Final Guidance, EPA/540/G-93/071 (EPA 1993b). These two data categories supersede the five QC levels (Levels I, II, III, IV, and V) defined in ***Data Quality Objectives for Remedial Response Activities, Development Process*** (EPA 1987a). The two new data categories are associated with specific QNQC elements and may be generated using a wide range of analytical methods. The two data categories are described below.

- **Screening data with definitive confirmation:** Screening data provide analyte identification and quantification using rapid, less precise analytical methods than definitive data. The primary difference between screening data and definitive data is the level of QNQC required. The QA/QC requirements for screening data are as follows:

  — sample documentation (location, date and time collected, batch, etc.);
  — sample chain-of-custody (when appropriate);
  — sampling design approach;
  — initial and continuing calibration;
  — determination and documentation of detection limits;
  — identification of compounds and analytes detected;
  — quantification of compounds and analytes detected;
  — analytical error determination; and
  — definitive confirmation.

  At least 10% of the screening data must be confirmed with definitive data. Screening data without the required confirmation are not recognized as being of known data quality.

- **Definitive data:** Definitive data are generated using EPA-approved or other nationally recognized analytical methods. Data are compound- or analyte-specific; the identity and concentration of the analyte are confirmed. Data can be generated onsite or at an off-site fixed-base laboratory as long as the following QA/QC elements are satisfied:

  — sample documentation (location, date and time collected, batch, etc.);
  — sample chain-of-custody (when appropriate);
  — sampling design approach;
  — initial and continuing calibration;
  — determination and documentation of detection limits;
  — identification of compounds and analytes detected;

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— quantification of compounds and analytes detected;
— QC blanks (trip, method, equipment rinseates);
— matrix spike recoveries;
— analytical error determination (measures precision of analytical method); and
— total measurement error determination (measures overall precision of measurement system from sample acquisition through analysis).

A combination of screening data and definitive data will be collected when this TSWP is implemented. Other than field measurements collected during water sampling events, all analyses will be done by a fixed-base laboratory. Table B.1 summarizes the data uses, data users, data categories, and data deliverable QC levels for each of the media and sample types that will be collected during this investigation.

3.3 INTENDED USES OF ACQUIRED DATA

The intended uses of the acquired data are to do these things:

- determine baseline levels of soil and groundwater Contaminants in the area planned for installation of the Six-Phase Heating (SPH) system;

- determine the impact of SPH technology on soil and groundwater contaminants and groundwater migration; and

- develop design criteria for full-scale installation of SPH as part of the remedial strategy if the technology is shown to be effective.

Data objectives are as follows.

- Scientific data generated will be of sufficient quality to withstand scientific and legal scrutiny.

- Data will be gathered or developed in accordance with procedures appropriate for its intended use. All field and laboratory methods/procedures specified for this project will comply with EPA requirements for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations.

- Data will be of known precision, accuracy, representativeness, completeness, and comparability (PARCC) within the limits of the project. Specific criteria for PARCC parameters have been established, as appropriate.

3.4 INTENDED USERS OF DATA

The primary users of data acquired during this investigation will be as listed.

- DOE, The Commonwealth of Kentucky, **EPA,** and the public will use data to select the remedial alternative.

- The Project Team will use the data to determine the effectiveness of SPH as a soil and groundwater remediation alternative and will present these results in a report to DOE. In consultation with DOE, EPA, and Kentucky Department for Environmental Protection (KDEP), the Project Team will decide on the next phases of work.

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Table B.1. Data uses and quality control levels

Field Activity/Media	Intended Uses	Intended Users[a]	Data Category
Health and safety monitoring and well development and purging	• Determination of appropriate protection levels for field personnel • Determination of well development completion	Field personnel GWOU Decision Makers Project Technical Support	None specified
Field Screening	• Measurement of water levels • Measurement of soil temperatures • Measurement of vacuum in soils during SPH operation • Screening soil samples for VOCs during sample collection • Screening samples for radiation before off-site shipment • Measurement of operational parameters	Project Manager Field Personnel GWOU Decision Makers Project Technical Support	Screening with definitive confirmation
Groundwater monitoring wells and soil borings	• Establish baseline contaminant concentrations • Measure impact and effectiveness of SPH on soils and groundwater • Support baseline risk assessment • Support FS	Project Manager Technical support staff GWOU Decision Makers Risk assessors	Definitive

[a]Secondary data users are listed. Primary data users include DOE, M&I Contractor, EPA, and Commonwealth of Kentucky personnel.
FS = Feasibility Study; NA = Not Applicable; TCE = trichloroethene; VOCs = volatile organic compounds

- The risk assessor(s) will use these data to conduct baseline human health and ecological risk assessments.

- The data management team will add these data to Paducah Oak Ridge Environmental Information System (OREIS).

3.5 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY

PARCC parameters are tools by which data sets can be evaluated. Evaluation of PARCC parameters helps ensure that DQOs are met. Table B.2 displays QA objectives for laboratory measurements.

- **Precision** refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions. To determine the precision of the laboratory analysis, a routine program of replicate analyses is performed. Duplicate field samples will be collected to determine total measurement (sampling and analytical) precision. The precision of field instrument measurements will be based on manufacturers' data (see Table B.3).

- **Accuracy** refers to the nearness of a measurement to an accepted reference or true value. To determine the accuracy, the evaluation is applied over the entire range of concentrations. To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples).

  In addition, a Laboratory Control Sample will be performed for each batch and plotted on control charts. Accuracy of the Laboratory Control Sample will be evaluated in accordance with laboratory statistical guidelines.

  Accuracy and precision of data collected in the investigation will depend on the measurement standards used and their meticulous, competent use by qualified personnel. Objectives for laboratory accuracy and precision for this project are shown in Tables B.2 and B.3. The compound-specific precision and accuracy objectives will be included in the laboratory QAPP and will be reviewed for appropriateness. Accuracy of field instruments will not be determined. However, frequent calibration and operational checks will be performed (see Sect. **6.1** of this QAPP) to ensure that instrument measurements are in control.

- **Representativeness** is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites, drilling sites, drilling depths, and analytical parameters and through the proper collection and handling of samples to avoid interference and minimize contamination and sample loss.

- **Completeness** is a measure of the percentage of valid, viable data obtained from a measurement system compared with the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs. For this project, the completeness objective for field and laboratory measurements is 90%.

- **Comparability** is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability will be assessed in terms **of** field standard operating procedures (SOPs), analytical methods, QC, and data reporting. In addition, data validation assesses processes employed by the laboratory that affect data comparability.

Table B.2. Quality assurance objectives for laboratory measurements

Parameter	Method	Matrix	Precision[a]	Accuracy	Completeness
TCL volatiles	SW-846[b] 8260	Water	13%	80 – 100%	90%
TCL volatiles	SW-846[b] 8260	Soil	22%	80 – 100%	90%
TCL semivolatiles	SW-846 8270	Water	13%	80 – 100%	90%
TCL semivolatiles	SW-846 8270	Soil	22%	80 – 100%	90%
TAL metals	SW-846 6010 and 7000 series	Water	20%	80 – 100%	90%
TAL metals	SW-846 6010 and 7000 series	Soil	35%	80 – 100%	90%
Gross alpha	EPA 900/HASL-300[c]	Water	20%	80 – 100%	90%
Gross alpha	EPA 900/HASL-300[c]	Soil	30%	80 – 100%	90%
Gross beta	EPA 900/HASL-300	Water	10%	80 – 100%	90%
Gross beta	EPA 900/HASL-300	Soil	25%	80 – 100%	90%
Sulfate	SW-846 9056	Water	30%	75 – 105%	90%
Sulfide	SW-846 9030 or EPA 376.1	Water	50%	50 – 150%	90%
Nitrate-nitrite	MCAWW353.3	Water	30%	90 – 110%	90%
Total Suspended Solids	MCAWW 160.2	Water	30%	75 – 105%	90%
Fluoride	MCAWW 340.2	Water	30%	75 – 105%	90%
Chloride	SW-846 9056	Water	30%	85 – 115%	90%
Radionuclides	Lab specific	Water	50%	80 – 100%	90%
Radionuclides	Lab specific	Soil	50%	80 – 100%	90%
Moisture content	ASTM D2216	Soil only	NA	NA	90%
Specific gravity	ASTM D954	Soil	NA	NA	90%
Oxidation/reduction potential	ASTM D1498	Water	NA	NA	90%
PH	SW-846 9045	Water	10%	90 – 110%	90%

Precision and accuracy values shown for radionuclides represent levels of 15 pCi/L and 15 pCi/g and above. Lower levels will have substantially wider precision and accuracy limits.
[a]Precision given as a relative percent difference based on replicates.
[b]EPA 1994. ***Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,*** Second Edition, Final Update 11, SW-846, September.
[c]This procedure is derived from a variety of sources including, but not limited to, ***Environmental Measurements Laboratory Procedures Manual,*** HASL-300 (DOE 1982) and ***Prescribed Procedures for Measurements of Radioactivity in Drinking Water*** (900 Series) (EPA 1980).
[d]EPA 1983b. ***Methods for Chemical Analysis of Water and Wastes,*** EPA-600/4-79-020, March.
TCL = Target Compound List; TAL - Target Analyte List; NA - not applicable.

NOTE: THIS TABLE DOES NOT REFLECT ANY WASTE MANAGEMENT REQUIREMENTS

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Table B.3. Quality assurance objectives for field measurements

Parameter	Matrix	Accuracy	Precision	Completeness
Total organic vapors (air monitoring)	Gas	ND[a]	—[b]	90%
Radiation health and safety (monitoring)	Aqueous, solid	ND	—[b]	90%
pH	Aqueous	ND	± 0.05 unit	90%
Conductivity	Aqueous	ND	± 50 units	90%
Temperature	Aqueous	ND	± 1°	90%
Temperature	Soil	ND	± 1°	90%
Water level	Aqueous	ND	f0.01 ft	90%
Gross alpha/gross beta	Aqueous, solid	ND	Instrument counting error	90%
Gross alpha/gross beta	Wipe of sample containers	ND	Instrument counting error	90%
Soil vacuum	Gas	ND	—[a]	90%

[a]Independent accuracy checks will not be determined in the field. Accuracy varies according to the type of instrument used. Instruments will be calibrated daily, or more frequently as specified in the manufacturers' guidelines. (See Section 6.1 of this QAPP for further information on equipment calibration procedures.)
[b]Direct reading instrument, incapable of reproducing a value without an air standard because atmospheric concentration varies and is unknown. Users will rely on calibration results to verify proper functioning of instrument.

ND = not determined

4. SAMPLING PROCEDURES

Sampling procedures are discussed in Sects. 1.3, 1.4, 1.5, and 1.6 of Appendix A of the TSWP, the Sampling and Analysis Plan *(SAP)*. The procedures to be used for this TS are PGDP-approved procedures.

5. SAMPLE CUSTODY

Sample custody procedures are addressed in Sect. 1.4.5 of Appendix A, the *SAP*.

6. CALIBRATION PROCEDURES AND FREQUENCY

6.1 FIELD EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCIES

The calibration of field instruments will be checked in the field in accordance with SAIC *QAAP* 12.1, "Control of Measuring and Test Equipment." Field calibration records will be documented in logbooks and on field data sheets. Calibration frequency is summarized in Table 8.4; an example field calibration record is given in **Fig.** B.1.

6.2 LABORATORY EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCIES

As required by BJC/OR-43, the laboratory(ies) will use written, standard procedures for equipment calibration and frequency. These procedures are based on **EPA** guidance or manufacturers' recommendations and are given in the EPA-approved analytical methods. Supplemental calibration details, such as documentation and reporting requirements, are given in the laboratory QA plan. The laboratory QA plan will be reviewed and approved by M&I Contractor as part of the laboratory review process. The appropriate references for all analytical parameters are included in the reference section of this document. When available, standards used for calibration will be traceable by the National Institute of Standards and Technology. Corrective action procedures for improperly functioning equipment will be addressed in the laboratory QA plan. Calibration records in accordance with the laboratory QA plan will be maintained for each piece of measuring and test equipment and each piece of reference equipment. The records will indicate that established calibration procedures have been followed. Records of equipment use will be kept in the laboratory files.

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Table B.4. Field equipment and calibration/functional check frequencies

Equipmentcheck frequency	Field usage	Frequency	Calibration/check	Calibration/functional material	Calibration check procedure
Total organic vapor analyzer[a]	Field screen, health and safety	Daily before use	At end of day	Traceable calibration gas	Manufacturer Specifications
On-line photoionization detector	Field screen, health and safety	Before shakedown, monthly during use, after heating	N/A	Traceable calibration gas	Manufacturer Specifications
Radiation detectors	Field screen, health and safety	Daily before use[b]	At end of day	Alpha, gamma, and beta radioactive sources	Manufacturer Specifications
Combustible gas indicator	Health and safety	Daily before use[b]	At end of day	Traceable methane	Manufacturer Specifications
Respirable dust monitor	Health and safety	Weekly during use	N/A	Zero bags	Manufacturer Specifications
pH meter	Field screen	Daily before use	At end of day	Traceable pH buffers	Manufacturer Specifications
Conductivity meter	Field screen	Daily before use	At end of day	Traceable conductivity standard	Manufacturer Specifications
Dissolved oxygen	Field screen	Daily before use	At end of day	Air-saturated waster	Manufacturer Specifications
Water level indicator	Field screen	Each use	N/A	Water	Manufacturer Specifications

[a]Photoionization detectors (except on-line photoionization detector), flame ionization detectors.
[b]These instruments are calibrated by the manufacturer. A functional check will be conducted daily before use to ensure that the equipment is working.
N/A = not applicable; EPA = U.S. Environmental Protection Agency.

IDENTIFIER	ITEM DESCRIPTION	CALIBRATION MEASUREMENT			BACKGROUND CHECK	RESPONSE CHECK	NAME	DATE
		PRE	ADJUSTMENT	POST				

Fig. B.l. Example of an equipment calibration log.

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7. ANALYTICAL PROCEDURES

7.1 OFF-SITE LABORATORY ANALYTICAL PROCEDURES

When available and appropriate for the sample matrix, SW-846 methods will be used. When not available, other nationally recognized methods such as those of EPA, DOE, and the American Society of Testing and Materials (ASTM) will be used. Table B.5 presents field measurement parameters for all TS and investigation-derived waste sampling. Tables B.6 through B.8 summarize the analytical methods and sample requirements for laboratory analytical parameters. Note that SW-846 methods will be used to analyze TCL/TAL compounds, which are listed in Table B.9.

Table B.5. Analytical parameters

Sample type	Analysis	
	Field measurements	**Laboratory analysis**
Environmental samples	Total organic vapors, radiation, pH, conductance, temperature, dissolved oxygen, water level (water media only), gross alpha and beta	Refer to Table B.6
Waste characterization samples	Not applicable	Refer to Table B.7

Method detection limits (MDLs) are the extent to which the equipment or analytical processes can provide accurate, minimum data measurements of a reliable quality for specific constituents. MDL is defined as the minimum concentration of a substance that can be measured and reported with **99%** confidence that the value is above zero. The actual quantitation limit for a given analysis will vary depending on instrument sensitivity and matrix effects. MDLs for fixed-base laboratory analyses for this project are shown in Table B.9.

The screening of environmental samples for gross alpha and gross beta will be performed by the PGDP analytical laboratory to meet Department of Transportation shipping and handling regulations. PGDP analytical methods will be followed for these analyses. Analytical sample volume, holding times, and sample containers are provided in Table B.10 for all screening analyses.

8. DATA REVIEW AND REPORTING

The data reduction, validation, assessment, and reporting for the TS will be performed in accordance with **RAAS-005,** "Quality Assured Data." To ensure that data management activities provide an accurate and controlled flow of data generated by the laboratory, it is important that the following data handling and reporting steps be defined and implemented.

8.1 DATA REDUCTION

Field program data will be produced by means of visual observation, direct-reading instrumentation, measuring devices, and performance of chemical analyses. All field activities, direct-reading instruments, and measuring devices will occur or be used in accordance with the SOPs and the specifications in the manufacturers' operations and maintenance manuals, **as** appropriate.

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Table B.6. Analytical methods and sample requirements for environmental samples

Parameter	Method No.	Matrix	Holding Time (from time of collection)	Sample Container	Preservative
TCL Volatile Organics	SW-846[a], 8021,8260	Water	14 days	Three 40-ml vials with Teflon-lined caps	HCl to pH <2 Cool to 4°C
TCL Volatile Organics	SW-846[a], 8021,8260 Prep 5030	Soil	14 days	4-oz. wide-mouth glass jar with Teflon-lined closure or brass liner	Cool to 4°C
TCL Semivolatile Organics	SW-846[a], 8270 Prep 3520	Water	14 days	Three 40 ml vials with Teflon-lined caps	HCl to pH <2 Cool to 4°C
TCL Semivolatile Organics	SW-846[a], 8270 Prep 3550	Soil	14 days	4-oz. wide-mouth glass jar with Teflon-lined closure or brass liner	Cool to 4°C
TAL Metals[b]	SW-846, 6010 and 7000 series*	Water	180 days (28 days for Mercury)	1-L polyethylene with polyethylene closure	HNO_3 to pH < 2 Cool to 4°C
TAL Metals[b]	SW-846, 6010 and 7000 series*	Soil	180 days (28 days for Mercury)	4-oz plastic jar	Cool to 4°C
Gross Alpha and Beta	SW-846, 93 10	Water	6 months	1-L polyethylene bottle	HNO_3 to pH < 2
Gross Alpha and Beta	No method for soil; lab specific	Soil	6 months	500-ml straight side	
Radionuclides	Lab specific	Water	6 months	500-ml Boston round 2-L polyethylene bottle	HNO_3 to pH < 2
Radionuclides	Lab specific	Soil	6 months	500-ml straight side	
Oxidation-reduction potential	ASTM[c] D 1498	Water	48 hours	16-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
pH	SW-846,9045	Water	Immediate	125-ml bottle	None
Specific conductance	SW-846,9050, EPA 100.1	Water	28 days	1-L polyethylene bottle	None
Sulfate	SW-846,9035	Water	28 days	125-ml bottle	Cool to 4°C
Sulfide	SW-846,9030	Water	7 days	260-ml amber glass	zinc acetate (2 mL) and NaOH to pH>9 Cool to 4°C

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Table B.6. (continued)

Parameter	Method No.	Matrix	Holding Time (from time of collection)	Sample Container	Preservative
Nitrate-nitrite	MCAWW[d] 353.3	Water	28 days	125-ml polyethylene bottle	Cool to 4°C
Total Suspended Solids	MCAWW 160.2	Water	7 days	2-L polyethylene with polyethylene closure	Cool to 4°C
Fluoride	MCAWW 340.2	Water	28 days	2-L polyethylene with polyethylene closure	Cool to 4°C
Chloride	SW-846,9056	Water	28 days	125-ml polyethylene bottle	Cool to 4°C
Temperature	EPA 170.1	Water	At collection	2-L polyethylene with polyethylene closure	None

Notes:
*Mercury has a 28-day holding time.
[a] EPA 1994. ***Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,*** Second Edition, Final Update II, **SW-846,** September.
[b] Samples for these parameters can occupy the same sample containers.
[c] American Society for Testing and Materials (1991). ***Annual Book of ASTM Standards.***
[d] EPA 1983. ***Methods for Chemical Analysis of Water and Waste*** (MCAWW), EPA/600-4-79/020, **U.S.** Environmental Protection Agency, March.

Table B.7. Analytical methods and sample requirements for investigation-derived waste analysis

Parameter	Method no.	Matrix	Holding time	Container	Preservation
Radionuclides[a] Gross alpha and gross beta (total and dissolved for water)	EPA 900/HASL-300[b]/ lab specific	Water	6 months	2-L polyethylene bottle	HNO_3 to pH<2
		Soil	6 months	8-oz. glass jar with Teflon-lined septum	
Other radionuclides[a]					
^{60}Co ^{99}Tc	Lab specific	Water	6 months	2-L polyethylene bottle	HNO_3 to pH<2
^{137}Cs ^{237}Np	Lab specific				
^{241}Am ^{239}Pu	Lab specific	Soil	6 months	500-ml straight side bottle	
^{234}U ^{230}Th	Lab specific				
^{238}U	Lab specific				
Volatile organic Compounds (including isopropanol)	SW-846,8260 Prep 5030	Water	14 days	Two 40-ml amber glass vials with Teflon-lined septum	HCL to pH<2 Cool to 4°C
		Soil	14 days	8-oz. wide-mouth jar with Teflon-lined closure	Cool to 4°C
Semivolatile organic Compounds	SW-846,8270 Water Prep 3520	Water	7 days to extraction 40 days'to analysis	One 1-L amber glass jar with Teflon-lined closure	Cool to 4°C
	Soil Prep 3550	Soil	14 days to extraction 40 days to analysis	8-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Metals (except mercury)	SW-846, 6010/7000 series Water Prep 3010 6010 series	Water	180 days (Hg = **28** days)	1-L polyethylene or amber glass jar with Teflon-lined closure	HNO_3 to pH<2 Cool to 4°C
	Water Prep 3020 7000 series Soil Prep 3050	Soil	180 days (Hg = 28 days)	8-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Cyanide	SW-846,9010	Water	14 days	Two 1-L polyethylene with Teflon-lined closure	NaOH to pH>10 Cool to 4°C
		Soil	14 days	4-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Pesticides/polychlorinated biphenyls	SW-846, 8080 Water Prep 3520	Water	7 days to extraction 40 days to analysis	Two 1-L polyethylene with Teflon-lined closure	Cool to 4°C
	Soil Prep 3550	Soil	14 days to extraction 40 days to analysis	16-oz wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Reactivity	SW-846 Section 7.3	Soil	None specified	8-oz. wide-mouth glass with Teflon-lined closure	Cool to 4°C

Table B.7. (continued)

Parameter	Method no.	Matrix	Holding time	Container	Preservation
Corrosivity	SW-846 Section 7.2	Soil	Non specified	8-oz. wide-mouth glass with Teflon-lined closure	Cool to 4°C
Moisture content[a]	ASTM[d]D22 16	Soil	14 days	8-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Chloride"	SW-846,9056	Water	28 days	125-ml polyethylene bottle	Cool to 4°C
Flash point	40 CFR 261.21	Soil	None specified	8-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Ignitability[a]	SW-846, 1010	Water	None specified	105-mL polyethylene with polyethylene closure	Cool to 4°C
Full toxicity characteristic	SW-846, 1311 followed by SW-846,8240,8270,8080, 6010,7470	Soil	VOCs: I4 days to extraction; 14 days to analysis. SVOCs and Pesticide/PCBs: 14 days to extraction; 7 days to preparation; 40 days to analysis. Mercury: 28 days to extraction; 28 days to analysis. Metals: 180 days to extraction; 180 days to analysis.	16-oz. wide-mouth glass jar with Teflon-lined closure	Cool to 4°C
Total suspended solids"	MCAWW-160.2	Water	See Table 7	1-L polyethylene	Cool to 4°C
Oil & grease	SW-846, 9070	Water	28 days	1-L glass bottle with Teflon-lined closure	H_2SO_4 to pH<2 Cool to 4°C
Total phosphorus	MCAWW-365.2	Water	See Table 7	250-ml polyethylene bottle	H_2SO_4 to pH<2 Cool to 4°C
Hexavalent chromium	SW-846,7197 Modified Prep.	Water	See Table 7	250-ml polyethylene bottle	Cool to 4°C
Chronic toxicity	EPA/600/4-89/001	Water	48 hours	To be determined	Cool to 4°C
Hardness	MCAWW-130.1	Water	See Table 7	1-L polyethylene	H_2SO_4 to pH<2 Cool to 4°C
pH[a] (normally a held parameter)	SW-846, 9045	Water	See Table 7	125-ml polyethylene bottle	None
Chlorine (total residual)" (normally a held parameter)	MCAWW 330.1	Water	As soon as possible	1-L polyethylene bottle	None

[a]Samples for these parameters can occupy the same sample container(s).
[b]This procedure is derived from a variety of sources including, but not limited to, ***Environmental Measurements Laboratory Procedures Manual***, HASL-300 (DOE 1982) and the ***Prescribed Procedures for measurements of Radioactivity in Drinking Water*** (900 Series) (EPA 1980).
[c] EPA 1994. ***Test Methods for Evaluating Solid Waste, Physical/Chemical Methods***, Second Edition, Final Update II, SW-846, September.
[d]American Society for Testing and Materials (1991). ***Annual*** Book of ***ASTM Standards.*** Method will be determined by analytical laboratory.
[e]U.S. Environmental Protection Agency (1983b). ***Methods for Chemical Analysis of Water and Wastes,*** EPA-600/4-79-020, March.

Table B.8. Target Compound List/Target Analyte List Parameters

Volatiles					
1.	Chloromethane	12.	1,2-Dichloroethane	23.	trans-1,3-Dichloropropene
2.	Bromomethane	13.	2-Butanone	24.	Bromoform
3.	Vinyl chloride	14.	1,1,1-Trichloroethane	25.	4-Methyl-2-pentanone
4.	Chloroethane	15.	Carbon tetrachloride	26.	2-Hexanone
5.	Methylene chloride	16.	Bromodichloromethane	27.	Tetrachloroethene
6.	Acetone	17.	1,2-Dichloropropane	28.	Toluene
7.	Carbon disulfide	18.	cis-1,3-Dichloropropene	29.	1,1,2,2-Tetrachloroethane
8.	1,1-Dichloroethene	19.	Trichloroethene	30.	Chlorobenzene
9.	1,1-Dichloroethane	20.	Dibromochloromethane	31.	Ethyl benzene
10.	1,2-Dichloroethene (total)	21.	1,1,2-Trichloroethane	32.	Styrene
11.	Chloroform	22.	Benzene	33.	Xylenes (total)
Semivolatiles					
1.	1,2,4-Trichlorobenzene	23.	4-Chlorophenylphenylether	45.	Diethylphthalate
2.	1,2-Dichlorobenzene	24.	4-Nitroaniline	46.	Dimethylphthalate
3.	1,3-Dichlorobenzene	25.	4-Nitrophenol	47.	Fluoranthene
4.	1,4-Dichlorobenzene	26.	Acenaphthene	48.	Fluorene
5.	2,4,5-Trichlorophenol	27.	Acenaphthylene	49.	Hexachlorobenzene
6.	2,4,6-Trichlorophenol	28.	Anthracene	50.	Hexachlorobutadiene
7.	2,4-Dichlorophenol	29.	Benzo(a)anthracene	51.	Hexachlorocyclopentadiene
8.	2,4-Dimethylphenol	30.	Benzo(a)pyrene	52.	Hexachloroethane
9.	2,4-Dinitrophenol	31.	Benzo(b)fluoranthene	53.	Indeno(1,2,3-cd)pyrene
10.	2,4-Dinitrotoluene	32.	Benzo(ghi)perylene	54.	Isophorone
11.	2,6-Dinitrotoluene	33.	Benzo(k)fluoranthene	55.	m,p-cresol
12.	2-Chloronaphthalene	34.	Benzylbutyphthalate	56.	N-Nitroso-di-n-propylamine
13.	2-Chlorophenol	35.	Bis(2-chloroethoxy)methane	57.	N-Nitrosodiphenylamine
14.	2-Methyl-4,6-dinitrophenol	36.	Bis(2-chloroethyl) ether	58.	Naphthalene
15.	2-Methylnaphthalene	37.	Bis(2-chloroisopropyl) ether	59.	Nitrobenzene
16.	2-Nitroaniline	38.	Bis(2-ethylhexyl)phthalate	60.	o-cresol
17.	2-Nitrophenol	39.	Carbazole	61.	Pentachlorophenol
18.	3,3'-Dichlorobenzidine	40.	Chrysene	62.	Phenanthrene
19.	3-Nitroaniline	41.	Di-n-butylphthalate	63.	Phenol
20.	4-Bromophenyl phenyl ether	42.	Di-n-octylphthlate	64.	Pyrene
21.	4-Chloro-3-methylphenol	43.	Dibenz(a,h)anthracene	65.	Pyridine
22.	4-Chloroaniline	44.	Dibenzofuran		
Metals					
1.	Aluminum	5.	Magnesium	9.	Nickel
2.	Potassium	6.	Total Fe	10.	Total Chrome
3.	Sodium	7.	Barium		
4.	Calcium	8.	Vanadium		
Radionuclides					
1.	^{60}Co	4.	^{234}U	7.	^{237}Np
2.	^{137}Cs	5.	^{238}U	8.	^{239}Pu
3.	^{241}Am	6.	^{99}Tc	9.	^{230}Th

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Table B.9. Method detection limits for Nuclear Regulatory Commission-licensed laboratory analyses

Water (µg/L)	Soil (µg/kg)	TCL Volatile Organic Compounds[a] SW-846,[b] 8260		
5	10	Benzene	1,2-Dichloroethane	[w]1,1,1,2-Tetrachloroethane
		Bromodichloromethane	1,1-Dichlorethene	Tetrachloroethene
		Bromoform	1,2-Dichloroethene (Total)	Toluene
		Carbon disulfide	1,2-Dichloropropane	Trans-1,3-dichloropropene
		Carbon Tetrachloride	[w] Ethyl methacrylate	"Trans-1,4-dichloro-2-butene (100)
		Chlorobenzene	Ethyl benzene	
		Chloroform		1,1,1-Trichloroethane
		Cis-1,3-dichloropropene	Methylene chloride	1,1,2-Trichloroethane
		Dibromochloromethane	Styrene	Trichloroethene
		"Dibromomethane	1,1,2,2,-Tetrachoroethane	"Trichlorofluoromethane
		[w]1,2-Dibromomethane		[w]1,2,3-Trichloropropane
				Xylenes (Total)
		1,1-Dichloroethane		
10	10	Bromomethane		Chloromethane
		Chloroethane		
50	50	2-Hexanone	4-Methyl-2-pentanone	Vinyl acetate
100	100	Acetone		
			2-Butanone	
2	10	Vinyl chloride (MDL for water meets EPA MCL)		

Water (µg/L)	Soil (µg/kg)	TCL Semivolatile Organic Compounds[a] SW-846,[b] 8270		
10	660	1,2,4-Trichlorobenzene	Acenaphthylene	Dimethylphthalate
		1,2-Dichlorobenzene	Anthracene	Di-n-butylphthalate
		1,3-Dichlorobenzene	Benzo(a)anthracene	Di-n-octylphthlate
		1,4-Dichlorobenzene	Benzo(a)pyrene	Fluoranthene
		2,4,5-Trichlorophenol	Benzo(b)fluoranthene	Fluorene
		2,4,6-Trichlorophenol	Benzo(ghi)perylene	Hexachlorobenzene
		2,4-Dichlorophenol	Benzo(k)fluoranthene	Hexachlorobutadiene
		2,4-Dimethylphenol	Benzylbutyphthalate	Hexachlorocyclopentadiene
		2,4-Dinitrotoluene	Bis(2-chloroethoxy)methane	Hexachloroethane
		2,6-Dinitrotoluene		Indeno(1,2,3-cd)pyrene
		2-Chloronaphthalene	Bis(2-chloroethyl) ether	Isophorone
		2-Chlorophenol	Bis(2-ethylhexyl)phthalate	Naphthalene
		2-Methylnaphthalene		Nitrobenzene
		2-Nitrophenol	Chrysene	N-Nitroso-di-n-propylamine
		4-Bromophenyl phenyl ether	Dibenz(a,h)anthracene	
			Dibenzofuran	N-Nitrosodiphenylamine
		4-Chlorophenylphenyl ether	Diethylphthalate	Phenanthrene
		Acenaphthene		Phenol
				Pyrene
20	1300	3,3'-Dichlorobenzidine	4-Chloro-3-methylphenol	4-Chloroaniline
50	3300	2,4-Dinitrophenol	2-Nitroaniline	4-Nitrophenol
		2-Methyl-4,6-dinitrophenol	3-Nitroaniline	Pentachlorophenol
			4-Nitroaniline	
not specified	not specified	Bis(2-chloroisopropyl) ether	Carbazole	o-cresol
			m,p-cresol	Pyridine

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Table B.9. (continued)

Water (µg/L)	Soil (mg/kg)	TAL Metals[b] SW-846,6010 and 7000 series	
25	25	Barium	
25	10	Manganese	
25	25	Vanadium	
25	25	Chromium	
50	5	Nickel	
200	20	Iron	
200	20	Aluminum	
2000	100	Calcium	
25	50	Magnesium	
2000	200	Sodium	
Water (µg/L)	**Soil (µg/kg)**	**Miscellaneous parameters (various methods)**	
1000		Sulfide	
		Nitrate-nitrite	
		Chloride	
		Fluoride	
Water (pCi/L)	**Soil (pCi/g)**	**Radionuclides**	**Method**
3	10	Gross Alpha and Beta	SW-846, 9310
not specified		^{60}Co	
17	8	^{99}Tc	Lab specific
not specified	3	^{137}Cs	
not specified	3	^{241}Am	
not specified	30	^{234}U	
not specified	30	^{238}U	
not specified	3	^{237}Np	
not specified	3	^{239}Pu	
not specified	5	^{230}Th	

[a] U. S. Environmental Protection Agency. ***Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,*** SW-846, Third Ed., November (EPA 1986). Values shown in this table are taken from this document and presented therein as both method detection limits and practical quantitation limits.
[b] SW-846 Methods 7470 and 7471 will be used to analyze for mercury in water and soil, respectively. Other metal analytes will be analyzed by SW-846, Method 6010, except for arsenic (Method 7060), lead (method 78421), selenium (method 7740, and thallium (method 7841), and hexavalent chromium (Method 7197).
[w] Water only.

NRC = Nuclear Regulatory Commission; TCL = Target Compound List; MDL = Method Detection Limit; EPA = U.S. Environmental Protection Agency; MCL = Maximum Contaminant Level; PCBs = polychlorinated biphenyls; TAL = Target Analyte List;

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Table B.10. Analytical methods and sample requirements for screening samples

Parameter	Method no.	Matrix	Holding time	Detection limit	Container	Preservation
Gross alpha and gross beta	PGDP method	Water	6 months	8 pCi/L alpha 10 pCi/L beta	Two 40-mL glass vials	None
		Soil	6 months	TBD	4-oz. wide-mouth glass jar with Teflon-lined lid	None

PGDP = Paducah Gaseous Diffusion Plant.

To present field data in a report, the data recorded in data books and forms will need to be summarized and transferred to tables, figures, maps, or logs. To analyze data, some data will need to be entered into computer databases or onto spreadsheets. The FTM, Field Supervisor, and other team members are responsible for data transfer activities pertinent to their roles on the project. The Project Data/Records Coordinator will ensure that data transfers to the Paducah Project Environmental Management System (PEMS) are performed accurately. Initially, 100% of the transfer activities will be checked. After the first two satisfactory transfers, 20% of the transfer activities will be checked. Data generated by laboratories will be reduced using the format specified by EPA or other standard methods. The analytical data will be checked for completeness and reasonableness. Laboratory data will be reconciled with field identifiers and will be transferred from the laboratory electronic data deliverable (EDD) to Paducah PEMS.

It will be the responsibility of the Project Data/Records Coordinator to ensure that all data transferred to tables, spreadsheets, logs, maps, figures, or into Paducah PEMS are transferred correctly. All copies (paper and electronic) of data transferred will be checked at least once for completeness and accuracy. All computer programs used to analyze or reduce data will be checked at least once with a data set of known results before the program is used to process data for any site.

8.2 DATA VERIFICATION, VALIDATION AND ASSESSMENT

The data review process consists of the verification, validation, and assessment of environmental measurements, waste management data, and analytical data from fixed-base and field laboratories. The data verification process determines if results have been returned for all samples, if the proper analytical and field methods have been used, if analyses were performed for the desired parameters, and if the requirements of any laboratory subcontracts have been met. The data validation process determines whether proper QC methods were used and whether the results met established QC criteria. The data assessment process determines whether data are adequate for its intended use. Any problems found during the review process are documented and resolved. Data management information/ requirements for data review are discussed in Sects. 7.10 and 7.11 of the SPH TSWP.

8.2.1 Data Verification

Verification of analytical data can be broken down into two steps, laboratory contractual screening and electronic Paducah PEMS verification. Laboratory contractual screening is the process of evaluating a set of data against the requirements specified in the analytical Statement of Work to ensure that all requested information is received. The contractual screening includes, but is not limited to, the COC, number of samples, analytes requested, total number of analyses, method used, QC samples analyzed, EDDs, units, holding times, and reporting limits achieved. The M&I Contractor Sample Manager is primarily responsible for the screening upon receipt of data from the analytical laboratory. Electronic Paducah PEMS verification is the process for comparing a data set against a set standard or contractual requirement, specific to the project. This electronic verification is performed by the Project Data Coordinator. Data is flagged, as necessary, and qualifiers are stored in Paducah PEMS for transfer to Paducah OREIS.

Verification of field measurements data consists of establishing that data are recorded correctly and that field instruments have been properly calibrated and ensuring the accuracy and completeness of all field forms and logbooks (e.g., sample information forms, chain-of-custody forms, requests for samples analysis, etc.). **Any** problems with the data will be documented, and preventive and possible corrective actions will be taken, if necessary.

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8.2.2 Data Validation

Data validation is the process of screening data and accepting, rejecting, or qualifying them on the basis of sound criteria. Data validation will be performed in accordance with EPA procedures and shall be validated at a target frequency of a minimum of 10% of all data packages. The following procedure, TP-DM-300-7, Data Validation, will be used to validate the data. Data will be validated, as appropriate, based on holding times, initial calibration, continuing calibration, blank results, and other QC sample results. The process includes these steps:

- reviewing data for compliance with contract provisions;
- reviewing data collection and analysis methods for conformance with established criteria such as the *SAP*, the **QAPP,** and the latest revision of the **EPA** SW-846 Test Methods (1994); and
- eliminating obvious errors by checking data for proper sample identification, transmittal errors, internal consistency, and temporal and spatial consistency.

8.2.3 Data Assessment

The data assessment process will be performed to determine whether the total set of environmental measurements data available to the project satisfies the requirements of the project DQOs. Data assessment will be performed by the **TS** project team. The evaluation is concerned with the set of all data collected during a project or phase of a project that is intended for use in characterization, risk assessment, or remedial action decisions.

Environmental measurements data must have completed the verification and validation phases before being assessed. The verification and validation of any existing data before assessment is required whenever possible, but the validation activity may not be possible for some existing data, given previous deliverable requirements. All QC data from a project or phase of a project are reviewed to evaluate the quality of the data. The total set of data for the project is reviewed for sensitivity and PARCC parameters.

An integral component of the data assessment process is the comparison of measurement results against the DQOs to determine if the data meet or exceed the "level of certainty" required for decision-making purposes. The field and analytical results are evaluated to see if the requirements determined by the DQO process were met by the sampling and analysis activities. A final determination of the usability of the data is made by the M&I Contractor Subcontract Technical Representative (STR) or designee. Data qualifiers are assigned to indicate the usability of the data for meeting project requirements.

8.3 DATA REPORTING

The fixed-base laboratories are required to report data in accordance with applicable DOE or BJC procedures. Data deliverables will be reported in a format that fulfills the requirements of these procedures. Two copies of each data package will be required. Equivalent information in accordance with these procedures will be reported for radionuclides and other parameters in accordance with these procedures.

For this project, all laboratory analyses will include definitive deliverables. For data presented with definitive deliverables, the laboratory will provide complete data packages, which exclude all raw data (formerly Level C).

9. INTERNAL QUALITY CONTROL CHECKS

SOPs are used for all routine sampling operations. Field QC sampling will be conducted to check sampling and analytical accuracy and precision for laboratory analyses of the original samples. If contaminants are found in the blanks, attempts will be made to identify the source of contamination, and corrective action will be initiated in accordance with Sect. 13 of this QAPP. The laboratory analyzing the samples also will include QC samples in accordance with the analytical method and the appropriate M&I Contractor procedures. These samples will be discussed in the laboratory's QA plan.

The QC field samples and frequencies summarized in this section will be used for this task. All QC samples will be shipped according to the chain-of-custody procedures specified in the *SAP* of the TWSP. The types of QC samples used in this study are described in the following text.

9.1 FIELD QUALITY CONTROL SAMPLES

Field QC samples will have sample numbers as described in the *SAP* of the TSWP. Duplicates will be submitted as "blind" to the laboratories. These samples will be analyzed for the parameters of interest; the results will be included in the analytical report.

- A **preservative blank** is prepared by putting analyte-free/organic-free water in the container and then presenting the sample with the appropriate preservative. A preservative sample will be analyzed at the beginning and end of the sampling program.

- A **trip blank** consists of a sealed container of ASTM Type II water that travels from the field to the laboratory with the samples to be analyzed for VOCs. The trip blank receives the same treatment as do sample containers and, therefore, identifies contamination that may have entered the field samples during transport. One trip blank will be placed in each cooler containing samples to be analyzed for VOCs.

- A **field blank** serves as a check on environmental contamination at the sample site. Distilled, deionized water is transported to the site, opened in the field, transferred into each type of sample bottle and returned to the laboratory for analysis of all parameters associated with that sampling event. It is also acceptable for field blanks to be filled in the laboratory, transported to the field, and then opened. Field blanks may be used as **a** reagent blank, as needed. Field blanks will be collected at a frequency of 1 in 20 samples (5%) for each sample matrix.

- ***An*** **equipment blank or rinseate sample** is a sample of deionized water passed through or over decontaminated sampling equipment. Equipment blanks are used as a measure of decontamination process effectiveness and are analyzed for the same parameters as the samples collected with the equipment. Equipment blanks may also be used as reagent blanks, as needed. Equipment blanks are required only when nondisposable equipment is being used. Equipment blanks will be collected at a frequency of 1 in 20 samples (5%).

- One **field duplicate** is collected for every 10 samples (10%) to determine whether the field sampling technique is reproducible. The field duplicate is collected from one sampling location, placed in a separate set of containers, and labeled with a different sample number.

- A **source water blank** is a sample of the deionized and/or potable water sources used for the project. These samples are collected at the beginning of the project and monthly if the project will be of long duration. Source water blanks are used to demonstrate that the source water is not contaminated.

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9.2 ANALYTICAL LABORATORY QUALITY CONTROL SAMPLES

Analytical laboratory QC samples will be analyzed as required by the analytical method for the parameters of interest; the results will be included in the analytical report.

- **Matrix spike (MS)/matrix spike duplicate (MSD)** samples require the collection of additional sample volume for aqueous samples. The laboratory splits the samples into duplicates and adds predetermined quantities of stock solutions to them before extraction and analysis. Percent recoveries are calculated to assess accuracy. Relative Percent Differences are calculated to assess analytical precision. MS/MSD samples will be analyzed at a frequency of 1 for every **20** samples (5%) for organic parameters. For inorganic parameters, a laboratory duplicate will be analyzed instead of an MSD.

10. AUDITS AND SURVEILLANCES

Audits and surveillances are conducted regularly by M&I Contractor QA staff to do the following:

- check for adherence to the QA/QC requirements specified in the project documents;
- evaluate the procedures used for data collection, data handling, and project management;
- verify that the QA program developed for this project is being implemented according to the specified requirements;
- assess the effectiveness of the QA program; and
- verify that identified deficiencies are corrected.

Specific procedures for scheduling and performing audits and surveillances are given in BJC/OR-43.

The **RAAS** Contractor Quality Manager is responsible for defining audits and surveillances and will perform or assign them according to a quarterly schedule that coincides with appropriate activities on the project schedule and sampling plans. Scheduled audits and surveillances may be supplemented by additional ones for any of the following reasons:

- significant changes are made in the QAPP,
- it is necessary to verify that corrective action has been taken on a deficiency reported in a previous audit, or
- additional audits or surveillances are requested by the M&I Contractor STR.

10.1 AUDITS

Audits are qualitative reviews of project activity to check that the overall QA program is functioning. Audits should be conducted early in the project so that problems can be corrected quickly. However, various aspects could be included in the semiannual M&I Contractor independent assessments scheduled for April and September of each year, depending upon fieldwork. The audit involves the review of all available and relevant project and contract documents and includes an evaluation of QC measures for office, field, and laboratory work.

Office audits evaluate the following:

- record keeping, including appropriate available field documentation, training, problem prevention, corrective action, monthly reports, and other documentation of project work and QA measures;

- preparation of deliverables specified in the work plan;

- proper technical and QA review of documents;

- QA systems and data validation; and

- filing and storage of documents in the central files.

One office audit will be conducted shortly after the initiation **of** fieldwork. The **RAAS** Contractor will provide results of the office audit to the M&I Contractor QA Manager.

Field audits examine the following procedures:

- cleaning, decontamination, and storage of sampling equipment and containers;
- sample collection, preservation, custody, and shipping procedures;
- preparation and frequency of collection of QC samples;
- calibration, operation, and maintenance procedures; and
- documentation of field activities in the field logbook or on appropriate data forms.

No field audits are planned for this task. However, periodic field surveillances will be conducted.

10.2 SURVEILLANCES

Surveillances follow the same general format as an audit but are less detailed and require a less formal report. A surveillance is designed to give project staff rapid feedback concerning QA compliance and facilitate corrective action.

For this project, one field surveillance is planned shortly after field mobilization. Additional field surveillances will be conducted approximately every 4 to **6** weeks of fieldwork or at critical milestones. The following activities and documentation will be subject to surveillance:

- monitoring well installation,
- groundwater sampling,
- decontamination,
- chain of custody,
- field documentation,
- field training records,
- equipment calibration, and
- field QC procedures.

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Other periodic surveillances may be scheduled by the RAAS Contractor QA Manager. The RAAS Contractor will provide results of the field surveillances to the M&I Contractor QA Manager. The M&I Contractor also may perform periodic surveillances. The surveillances will be integrated between the RAAS Contractor and the M&I Contractor QA Managers to minimize duplication of effort.

11. PREVENTIVE MAINTENANCE

Periodic preventive maintenance is required for all sensitive equipment. The troubleshooting sections of factory manuals will be available to personnel performing maintenance tasks. The frequency of preventive maintenance for field equipment will be performed in accordance with the RAAS Contractor's approved procedures manual. The RAAS Contractor's Preventative Maintenance Procedures will be reviewed for consistency with M&I Contractor procedures before implementation. In addition, the RAAS Contractor will indicate when routine maintenance checks are necessary so that failures in the field can be minimized. A list is maintained of the critical spare parts that should be stocked to minimize equipment downtime. Specific field equipment preventive maintenance practices, frequencies, and spare parts are described in the factory manual for each instrument.

Preventive maintenance procedures for laboratory equipment and instruments are provided in laboratory QA plans. All maintenance activities will be recorded in maintenance logs. Laboratories will be required to maintain an adequate inventory of spare parts and consumables to prevent downtime as a result of minor problems.

12. SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

The precision, accuracy, and completeness parameters are quantitative tools by which data sets can be evaluated. These parameters can help ensure that DQOs are met. Procedures for assessing them are provided in the following text.

12.1 PRECISION

To determine the precision of the laboratory analysis, a routine program of replicate analyses in accordance with the analytical method requirements is performed by the laboratory. The results of replicate analyses are used to calculate the relative percent difference, which is used to assess laboratory precision.

For replicate results C_1 and C_2

$$\textit{Relative Percent Difference} = \frac{|C_1 - C_2|}{\frac{(C_1 + C_2)}{2}} \times 100$$

The precision of the total sampling and analytical measurement process will be assessed based on field duplicates. Although a quantitative goal cannot be set due to field variability, the **RAAS** Contractor will review field duplicate relative percent difference values to estimate precision.

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12.2 ACCURACY

To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per **20** samples). The results of sample spiking are used to calculate the QC parameter for accuracy evaluation, the percent recovery (% R).

For surrogate spikes and QC samples:

$$\% R = \frac{C_s}{C_t} \times 100$$

where
C, = measured spiked sample concentration (or amount),
C_t = true spiked concentration **(or** amount).

For matrix spikes:

$$\% R = \frac{/C_s - C_o/}{C_t} \times 100$$

where
C, = measured spiked sample concentration,
C_o = sample concentration (not spiked),
C_t = true concentration of the spike.

The accuracy of the total sampling and analytical measurement process will not be determined because such a determination would require the addition of chemical spiking compounds to the samples in the field.

12.3 COMPLETENESS

To determine the completeness of data, the percentage of valid, viable data obtained from a measurement system is compared with the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs.

Completeness (C) is calculated as follows:

$$\% C = \frac{\textbf{Number of valid measurements}}{\textbf{Number of total measurements}} \times 100$$

13. NONCONFORMANCES AND CORRECTIVE ACTION PROCEDURES

13.1 NONCONFORMANCES

Nonconforming equipment, items, activities, and conditions and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in accordance with SAIC QAAP 15.1, "Control of Nonconforming Items and Services." The FTM or Project Manager initiates the nonconformance reporting and corrective action process by completing a Nonconformance

Report, shown in Fig. R.2. Nonconforming equipment will immediately be labeled or tagged and segregated, if possible. Specific procedures for controlling nonconforming items will be described in RAAS Contractor's approved **QA** Manual.

13.2 CORRECTIVE ACTION

The M&I Contractor corrective action system is described in BJC/OR-43. This procedure requires that conditions adverse to quality be identified and documented and that corrective action be taken and verified. Specific procedures for controlling nonconforming items and the corrective action systems of the subcontractor laboratories are contained in the respective laboratory **QA** plans. Other team subcontractors are required to follow equivalent corrective action procedures.

Each project team member is responsible for notifying the FTM, the Project Manager, the **QA** staff, or other responsible persons if he/she discovers a condition that may affect the quality of the work being performed. The following staff members have specific corrective action responsibilities.

- **RAAS** Contractor Site Manager—Overall responsibility for implementing corrective actions.
- **RAAS** Contractor Quality **Manager**—Overall responsibility for tracking and accepting corrective actions.
- **RAAS** Contractor Project Manager—Implementing task-specific corrective actions.
- **RAAS** Contractor FTM—Identifying and implementing corrective actions during field activities. Notifying the Project Manager and **QA** staff of conditions not immediately corrected.
- **M&I** Contractor Sample Management Office—Identifying and implementing corrective action during analysis. Notifying the Project Manager and **QA** Specialist when applicable acceptance criteria or DQOs are not satisfied.

Immediate corrective actions will be noted in task notebooks. Problems not immediately corrected will require formal corrective action as described in the Paducah RAAS QAPP.

14. QA REPORTS TO MANAGEMENT

All levels of the RAAS Contractor's **QA** team are responsible for preparing **QA** reports, including these:

- Monthly QA Staff Reports. The RAAS Contractor's **QA** Manager will submit a monthly activity report to the M&I Contractor STR with a copy provided to the M&I Contractor **QA** Specialist. Each report will summarize:
  - — **QA** activities during the reporting period,
  - — system and performance audits conducted (internal and external),
  - — quality problems found, and
  - — corrective actions initiated.

NONCONFORMANCE REPORT	DATE OF NCR	NCR NUMBER
	LOCATION OF NONCONFORMANCE	PAGE____OF ____
INITIATOR (NAME/ORGANIZATION/PHONE)	FOUND BY	DATE FOUND
RESPONSIBLE ORGANIZATION / INDIVIDUAL		PROGRAM
		PROJECT
DESCRIPTION OF NONCONFORMANCE		CATEGORY ________________

A INITIATOR: DATE QA/QC OFFICER DATE CAR REQ'D YES ☐ NC ☐

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

B PROPOSED BY: NAME DATE

JUSTIFICATION FOR ACCEPTANCE

C INITIATOR: NAME DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES ☐ NO ☐ IF YES; DATE RESULT

D QUALITY ASSURANCE: NAME DATE

Fig. B.2. Nonconformance Report Form.

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- **Audit, Surveillance, and Inspection Reports.** The results of each QA audit, surveillance, or inspection will be documented in a report that is distributed within **30** working days of the action.

- **QA Sections in Project Reports.** All reports that present measurement data generated during the work assignment must include a QA section addressing the quality and limitations of the data. At a minimum each QA section will address the following:

  — precision, accuracy, and completeness achieved for reported measurement data in relation to goals for these indicators;

  — results of audits or surveillance of the measurement work;

  — quality problems found and corrective actions taken; and

  — deviations from the SAP and QAPP.

All reviews and document checks will be documented. Deliverables produced for this project will be subject to three reviews.

- The **technical review,** performed by senior professionals who have not been involved in project management or data collection activities, ensures that technical statements, conclusions, and recommendations are justifiable and defensible.

- The **QA review,** conducted by QA staff, ensures that QA/QC requirements have been addressed.

- The **final review,** performed by the Project Manager, ensures that the document addresses all contractual requirements.

15. QUALIFICATIONS AND TRAINING OF PERSONNEL

Personnel assigned to the project, including field personnel and subcontractors, will be qualified to perform the tasks to which they are assigned. Resumes of project personnel will be provided to M&I Contractor to document their training and experience. In addition to education and experience, specific training may be required to qualify individuals to perform certain activities, see Table 1, Training Matrix, of the Environmental, Safety, and Health Plan (ES&HP). Training will be documented on appropriate forms, which will be placed in the project file. Project personnel will receive an orientation to the TSWP, the ES&HP, and the QAPP, as well as to their responsibilities before participating in project activities. A field planning meeting will be the forum for the orientation. All field personnel will be required to read and familiarize themselves with the *SAP*, QAPP, and ES&HP before completing any work at the site. All sampling procedures will be performed in compliance with the TSWP. A copy of the following documents will be available to all field personnel while in the field:

- the Paducah RAAS QAPP; and
- the TSWP, which include these;
  — the *SAP* (Appendix A),
  — the QAPP (Appendix B),
  — the Data Management Plan (Section 7 of TSWP)

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- the ES&HP (Appendix C), and
- the Waste Management Plan (WMP) (Appendix D).

At a minimum, records of required reading reports and attendance lists will be maintained.

16. FIELD CHANGES

BJC/OR-43 requires that field changes be governed by control measures commensurate with those applied to the documentation of the original design. The procedure for controlling field changes is discussed in the following text.

- Major changes from approved field operating procedures or project scope, cost, or schedule will be documented on a field change request form, shown in **Fig.** B.3. The FTM will initiate and maintain the field change request forms.

- Each field change request form requires the approval of the M&I Contractor STR before work proceeds. Weekly quality status reports serve as the mechanism for notifying the QA staff of field changes. The M&I Contractor QA Manager must approve changes related to quality and receive copies of field changes. Approval by the M&I Contractor STR can be initiated verbally via telephone, with follow-up sign-off. In no case will a subcontractor initiate a field change. If a field change is proposed by the client, it will be ***so*** recorded. Copies of the field change request forms will be kept on-site until the fieldwork is complete and then will be transmitted to the project files.

- Variances or minor changes to field operating procedures will be documented in the field logbook and included in a variance log. The variance log will be used to track the **type** of variance and the logbook in which the variance was reported.

- If deemed necessary, the work plan, *SAP,* QAPP, ES&HP, or other relevant documents will be revised, reviewed, approved, and reissued with control measures commensurate with the original documents. The M&I Contractor STR must approve each field change request form before work proceeds.

- Specific additional requirements for field changes such as required PGDP approvals will be addressed in contractual documentation between PGDP and its implementing subcontractor. The M&I Contractor QA Specialist must approve all field changes that impact the quality of the project before work proceeds.

17. DOCUMENT CONTROL AND RECORDS MANAGEMENT

Document control and records management are addressed in the Data Management Plan, Section 7 of the SPH TSWP.

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FIELD CHANGE REQUEST FORM

Change No.: ____________________

Requested By: ____________________ Date: ____________

Contract/Task No. ____________________ Task Manager: ____________

Applicable Document ____________

Applicable Section ____________

Circle: MAJOR / MINOR Change

Description of change impact: ____________

Reason for change: ____________

Estimated cost: ____________

Approved by: ____________________ (Field Task Manager) Date: ____________

Approved by: ____________________ (BJC CE) Date: ____________

Approved by: ____________________ (BJC STR) Date: ____________

Approved by: ____________________ (BJC QA Specialist) Date: ____________

PADUCAH GASEOUS DIFFUSION PLANT
Paducah, Kentucky

cc: Robert Pratt, Bechtel Jacobs Company LLC
Lance Fleming, Bechtel Jacobs Company LLC

Fig. B.3. Field Change Request Form.

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APPENDIX C

ENVIRONMENTAL, SAFETY, AND HEALTH PLAN FOR SIX-PHASE HEATING TREATABILITY STUDY

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TABLES

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ACRONYMS AND ABBREVIATIONS

ACGM	American Conference of Governmental Industrial Hygienists
AHA	activity hazard assessment
AMA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ANSI	American National Standard Institute
BJC	Bechtel Jacobs Company LLC
CFR	***Code of Federal Regulations***
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
ES&H	environmental, safety, and health
ES&HP	environmental, safety, and health plan
EZ	exclusion zone
FID	flame ionization detector
FS	field supervisor
GET	General Employee Training
HAZWOPER	Hazardous Waste Operations and Emergency Response
HP	health physics
HS	health and safety
ISMS	Integrated Safety Management System
MSDS	material safety data sheet
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PPE	personal protective equipment
PSS	plant shift superintendent
RAAS	Remedial Action Assessment Subcontract
RCT	radiological control technician
RPP	Radiological Protection Program
RSP	radiation safety plan
RWP	radiological work permit
SAIC	Science Applications International Corporation
SPH	Six-Phase Heating
SSHR	site safety and health representative
STR	subcontract technical representative
TCE	trichloroethylene
TS	treatability study
TLV	threshold limit value
VOC	volatile organic compound
WBGT	wet-bulb globe temperature
WR	**work** release

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EXECUTIVE SUMMARY

This environmental, safety, and health plan (ES&HP) establishes the specific applicable standards and practices to be used during execution of the Six-Phase Heating (SPH) system.

This ES&HP incorporates directly or by reference the applicable provisions of Exhibit G—***Environmental, Safety, and Health Requirements,*** the Science Applications International Corporation (SAIC) Environmental Compliance & Health and Safety (EC&HS) Program, federal and state standards, and pertinent consensus standards. This ES&HP is developed and implemented in accordance with 29 ***Code of Federal Regulations*** **1926.65,** Hazardous Waste Operations and Emergency Response. Additional specific health and safety (HS) requirements will be incorporated into this work plan for the various field activities that comprise the SPH systems through completion of activity hazard assessments. The requirements of the ES&HP and related addenda apply to SAIC and lower-tier subcontractors.

As "lessons learned" are incorporated, this ES&HP will evolve to improve work processes continuously while maintaining focus on the functions and guiding principles of the Integrated Safety Management System and the zero-accident performance philosophy.

SAIC will implement an SPH system treatability study involving the installation of wells for contaminant extraction and placement of seven electrodes into the soil at the southeast corner of the C-400 Building and the construction and operation of the heating/extraction/treatment system. The **SPH** system will be used in a pilot test for removing trichloroethene (TCE) in the subsurface. The TCE is believed to be the source of contamination of the groundwater plume at the site. ***(References Exhibit*** G ***matrix; Integrated Safety Management System Items*** 1 ***and 2.)***

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1. INTRODUCTION

This environmental safety and health plan (ES&HP) has been developed for the Six-Phase Heating (SPH) system to comply with applicable Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) and other federal occupational safety and health requirements, including those of the **U.S.** Department of Energy (DOE). This ES&HP establishes umbrella radiological, health and safety (HS) requirements and information applicable to Bechtel Jacobs Company LLC (BJC) operations.

This ES&HP is available to SPH participants in written and electronic forms. The term "SPH participants" refers to anyone performing SPH work, including the Science Applications International Corporation (SAIC) team, its subcontractors and their lower-tier subcontractors, consultants, and agents. It is SAIC's intent to perform this work in accordance with SAIC's Integrated Safety Management System (ISMS) and its Environmental Compliance and Health and Safety policy statement, which establishes a goal of zero accident performance. The SAIC Environmental Compliance & Health and Safety Program supplements this document. *(References **Exhibit** G **matrix;** ISMS Item 2.)*

2. SCOPE AND APPLICABILITY

SPH systems have been demonstrated to remove volatile and semivolatile contaminants effectively from soils. To implement the technology, soil vapor extraction and electrode wells are drilled into the contaminated zone, and electrodes are placed in the ground surrounding the contaminated region. Each electrode is connected to a separate transformer to provide it with a separate current phase. The electrode spacing and the connected electrical phases are both 60° apart, resulting in a uniform ratio of voltage difference to the physical distance between all electrodes in the array. A seventh, neutral electrode is located at the center of the array.

When electrical power is delivered, current conducts through the soil moisture, which heats the soil resistively. This heating volatilizes contaminants and water in the soil (producing steam), effectively steam-stripping contaminants in situ. The volatilized contaminants and steam are then removed by soil-vapor extraction wells and are treated above ground. This process results in accelerated and more complete removal of target contaminants from soil and groundwater compared to conventional soil-vapor extraction and does not require major excavation.

The only additive required for SPH is water, which normally is added to the vadose-zone soil surrounding the electrodes during operation. This prevents the soil adjacent to the electrodes from drying out and becoming nonconductive. However, some aquifers contain sufficient moisture to keep the electrodes conductive throughout the operation.

The components required to implement SPH are electrodes, vapor extraction wells, an off-gas collection and treatment system (including piping, a blower, a condenser, and treatment unit), an SPH power supply used to condition power for application to the soil, and a computer control/data acquisition system. A schematic of the system is presented in Fig. 2.1 in the SPH Treatability Study (TS) Work Plan. Throughout the operation, continuous remote control **of** power via personal computer maintains optimum power delivery.

The volatile contaminants are collected and processed in an off-gas treatment unit. **As** the soil is cleaned, contaminant concentrations in the off-gas decrease. When both off-gas and groundwater contaminant concentrations reach acceptable levels (site and contaminant specific), the demonstration is terminated.

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SPH is implemented in arrays of six electrodes arranged in a hexagonal pattern around a central neutral electrode. ***An*** array can be as large as 14 m (45 ft) in diameter, effectively heating a 19-m-(63-ft-) diameter region of soil. To treat large volumes of soil, several arrays are operated simultaneously, or the heated region can extend to a great depth [up to 61 m (200 ft) below ground surface]. The maximum volume of soil treated is governed by the power delivery capability of the SPH transformer [i.e., 10,000 m^3 (12,000 yd^3) of soil can be treated with a 1250 kW power supply]. For the Paducah Gaseous Diffusion Plant (PGDP), the SPH system is expected to treat approximately 3000 m^3 (3400 yd^3).

The field tasks to be performed include the following:

- mobilization of drilling equipment,
- installation of electrode and soil gas extraction wells,
- demobilization of drilling equipment,
- mobilization of off-gas treatment unit,
- installation of electrodes,
- construction of off-gas treatment unit and connection of electrodes and soil gas extraction well, and
- operation of SPH.

The **SAIC** team acknowledges that potential hazards are inherent to the performance of SPH field operations conducted at the PGDP. To control these hazards the **SAIC** team will make every effort to identify the hazards associated with each task and develop controls to remove or minimize these hazards. Should any condition change beyond the scope of existing controls, new controls shall be developed and documented, and training of affected team members shall be conducted. Accordingly, the SAIC team expects that SPH work will be conducted in a safe and healthful manner that minimizes the threat and occurrence of hazards to health, property, and the environment to as low as reasonably achievable (ALARA) levels. SPH participants are responsible for conducting work in accordance with applicable federal, state, and local regulations and DOE and BJC requirements.

The **SAIC** team shall comply with the ES&HP, any approved revisions to the **ES&HP**, the **SAIC** programs, and any site-specific plans and procedures that have been approved by BJC in relation to the work. Individuals performing SPH operations shall keep the ES&HP readily available for reference. Where there is concern that implementation of work orders or HS requirements would conflict with contract terms or could unreasonably compromise the safety or health of an individual or the environment, such concerns should immediately be brought to the attention of the subcontract technical representative (STR) and the site safety and health representative (SSHR). All SPH participants are authorized to immediately stop any SPH activity that poses unreasonable risk to persons or the environment. ***(References Exhibit*** G ***matrix; ISMS Items*** *I* ***and 2.)***

3. INTEGRATED SAFETY MANAGEMENT

SAIC will pursue its goal of zero accident performance through project-specific implementation of its ISMS. Project-specific implementation of this system is illustrated in Table C.1.

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Table C.1. Implementation of ISMS

1. Management commitment and leadership. Subcontractor management's commitment to achieving and sustaining zero accident performance and zero unpermitted discharges or releases with respect to the environment.	Line management responsibility for ES&H is specified in Sect. **4** of the ES&HP.
2. Define scope of work. Subcontractor's process for translating the subcontractor scope of work into specific work activities (tasks).	The scope and methods of accomplishment are described in the project work plan and in Sect. 1 in the ES&HP. The project scope will be reviewed in the SAIC readiness review. The project scope will be discussed during project kick-off and in site-specific training required by Sect. **13** of the ES&HP.
3. Hazards associated with scope of work. Subcontractor shall define the process to identify and analyze hazards associated with the scope of work.	The hazards and relevant controls associated with this scope are presented in the AHAs attached to the ES&HP. These AHAs will be presented as part of site-specific training.
4. Develop and implement hazard controls. Subcontractor's process for identifying applicable standards and requirements in order to effectively control hazards associated with the scope of work.	The relevant standards have been identified in a Work Smart Standards Crosswalk attached to the ES&HP (Attachment H). Requirements to implement are presented in Sect. **4** of the ES&HP.
5. Define the process to implement standards and requirements. Subcontractor shall describe how work will be performed in accordance with identified standards and requirements.	Section **4 of** the ES&HP presents the responsibilities to ensure that work is performed in accordance with requirements. The AHAs attached to the ES&HP incorporate the relevant requirements of the applicable standards and requirements.
6. Identify the process for reviewing, addressing, and communicating lessons learned. Subcontractor shall define the process for reviewing, addressing, and communicating lessons learned as part of their program implementation and flow down of requirements.	On a project level, lessons learned will be raised and discussed in the daily safety briefings. The lessons learned approach identified in Sect. 18 of the SAIC QA Program document will be used to promulgate lessons learned.
7. Identify the process of worker feedback and continuous improvement. Subcontractor shall identify the process for collecting and managing the feedback information, identifying continuous improvement opportunities, implementing corrective actions, and assuring worker participation in continuous improvement opportunities.	Worker feedback is part of the daily safety briefings required in Sect. 13 of the ES&HP. The lessons learned approach identified in Sect. 18 of the SAIC QA Program document will be used to promulgate lessons learned.
8. Approach for flow down of ES&HP requirements. Subcontractor shall identify the process to ensure that applicable ES&HP requirements flow down to all employees and lower-tier subcontractors.	ES&HP requirements have been incorporated into subcontract requirements. In addition, the field manager and SSHR will directly oversee on-site work to ensure safe performance.
9. Subcontractor selection (ES&H) process. Subcontractor shall identify the ES&H criteria they will use when selecting lower-tier subcontractors.	SAIC Remedial Action Assessment Subcontract team members were screened to ensure they meet BJC ES&H criteria. Project-specific subcontractors' qualifications include prior experience and concurrent operation on the Paducah facility.

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Table C.l. Implementation of ISMS (continued)

10.	Compliance, responsibility, and accountability. Subcontractor shall define process to ensure that line management is responsible and accountable for ES&H performance and compliance with all applicable regulatory and subcontract requirements.	Section 4 of the ES&HP specifies the ES&H responsibilities of the project manager and the field manager. It is SAIC's standard policy that managers are responsible for the safe execution of their work.
11.	ES&H incentives. Subcontractor shall describe the process to measure ES&H performance and provide recognition for meeting and/or exceeding established goals.	SAIC has an established bonus program applicable to exceptional performance in any field. In addition, as an employee-owned company, all SAIC personnel are stockholders. This arrangement leads to a very high level of employee empowerment and motivation.

AHA = activity hazard assessment
BJC = Bechtel Jacobs Company LLC
ES&H = environmental, safety, and health
ES&HP = environmental, safety, and health plan
QA = quality assurance
SAIC = Science Applications International Corporation
SSHR = site safety and health representative

4. ROLES, RESPONSIBILITIES, AND AUTHORITY

The general policies and personnel roles, responsibilities, and authorities provided in this section have been established to clarify expectations of **TS** participants and to comply with **BJC,** SAIC, and OSHA HAZWOPER requirements **[29** ***Code of Federal Regulations (CFR)*** **1926.65(b)(2)]**. **Table** C.2 outlines roles and contact information. ***(References Exhibit*** G ***matrix; ISMS Items*** *I* ***and*** *10.)*

Table C.2. Roles and Contact Information

Role	Telephone	Contact
PGDP PSS	(270) 441-6211	
DOE Project Manager	(270) 441-6831	Gary Bodenstein
BJC STR	(270) 441-5060	Robert Pratt
BJC safety advocate	(270) 441-5227	Mike Baker
BJC health physics	(270) 441-5123	Kelly Ausbrooks
SAIC project manager	(270) 462-4554	Eric Morti
SAIC site safety and health rep.	(270) 462-4544	Mike Crenshaw
SAIC field manager	(270) 462-3883	Jeff Douthitt
SAIC field supervisor	(270) 559-3332	Virginia Mullins
SAIC field operations manager	(270) 519-7415	Jim Ballard

BJC = Bechtel Jacobs Company LLC
PGDP = Paducah Gaseous Diffusion Plan
PSS = plant shift superintendent
SAIC = Science Applications International Corporation
STR = subcontract technical representative

4.1 SAIC PROGRAM MANAGER

The program manager has overall responsibility and authority to direct the technical, management, cost, and contractual matters related to the Remedial Action Assessment Subcontract (RAAS). The program manager is ultimately responsible for the safety and health of employees performing project-associated activities on the site.

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Specific responsibilities will include, but not be limited to, the following:

- serves as primary point of contact with BJC STR,

- identifies required environmental, safety, and health (ES&H) needs and ensures that project staff are trained in requirements,

- implements and enforces the ES&H plan, activity hazard assessments (AHAs), and other addenda,

- serves as consultant on safety-related matters with the site supervisors, safety and health manager, and SSHR,

- participates with the site supervisors, safety and health manager, and SSHR in investigations or disciplinary actions for violations of the ES&H plan, and

- ensures that the ISMS philosophy is a communicated to every SAIC team member.

4.2 SAIC CORPORATE SAFETY AND HEALTH OFFICER

The corporate safety and health officer has the following responsibilities and authorities for the **RAAS:**

- reviews and approves all project **HS** plans,
- oversees implementation of project **HS** plans and procedures,
- oversees corporate ES&H surveillances and audits, and
- directs and mentors safety and health manager.

4.3 SAIC SITE SAFETY AND HEALTH REPRESENTATIVE

The SSHR will be responsible for reviewing and authorizing the ES&HP, the AHA, and any and all changes made to these plans. The SSHR will be responsible for the implementation of the ES&HP/AHA, will serve as the point of contact for all health-and-safety-related matters, and will provide technical information regarding health and safety to site personnel. This individual will also oversee site activities with respect to health and safety issues and will stop work if conditions are determined to be detrimental to site personnel.

The **SSHR** has the following responsibilities and authorities for the **RAAS:**

- during field work, conducts daily (documented) HS inspections of the SAIC team's work activities and joint weekly inspections with the BJC safety advocate;

- stops work and removes SAIC team personnel from the site if the safety or health of the SAIC team personnel, other site personnel, or third parties is jeopardized by work activities;

- provides project-specific training for new employees and visitors;

- implements applicable **HS** procedures;

- maintains systems to inform personnel on how to respond to emergency warning systems for the project (including evacuation alarms, accountability rosters, assembly points, etc.);

- during fieldwork activities, participates in plan-of-the-day meetings;
- ensures that the first-aid kits are kept current;
- ensures that proper chemical and safety postings are in place and legible;
- ensures that all operations are conducted ***so*** as to mitigate adverse environmental impacts (e.g., spill containment, erosion control, etc.);
- maintains the hazard communication program [including material safety data sheets (MSDSs), training, etc.];
- evaluates the site for any hazards not identified in the **AHA,** initiates safety measures required to protect personnel, and revises documents accordingly;
- maintains programs required to mitigate hazards identified in **AHA;**
- maintains first-aid logs, reports accidents and injuries through the appropriate channels, and conducts accident/incident investigations as required, including the completion of appropriate forms;
- coordinates with off-site emergency responders and medical service organizations to establish required services and verify that phone numbers, addresses, and contacts are current and accurate; and
- ensures that the **ISMS** philosophy is used for the project.

4.4 SAIC FIELD SUPERVISOR

The field supervisor **(FS)** is the on-site line manager of the field team. He/she oversees the work of one or more supervisors of the field team and the team members.

Specific **HS** responsibilities of the FS, or his/her delegate, include the following:

- ensuring that all known tasks and associated hazards, protective controls and personnel have been identified sufficiently (e.g., in the ES&HP);
- ensuring that each concerned party has reviewed the ES&HP for accuracy and adequacy, also ensuring that review comments are resolved and that the ES&HP is signed before any field activities are begun;
- ensuring that provisions of the ES&HP, any supplements, and other applicable **HS** regulations are current and implemented for SPH field operations;
- ensuring that only field team members and support personnel qualified in accordance with applicable **HS** requirements are used to perform **SPH** work, and that only qualified individuals are allowed access to site locations or operations where potential hazards exist;
- ensuring that field team members attend **HS** briefings and daily **HS** tailgate meetings;
- ensuring that necessary permits have been obtained before commencing field operations;
- ensuring that the necessary preventive planning and employee training for emergency situations has occurred before beginning field operations;

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- conducting necessary inspections; and
- showing leadership in the flow down of the ISMS philosophy.

4.5 SAIC TEAM FIELD TEAM MEMBERS

Field team members are responsible for performing work in a safe and healthful manner. They are responsible for abiding by requirements of the ES&HP, any supplements, and other applicable HS regulations and procedures, and for fulfilling and maintaining their individual training and medical surveillance requirements. If there is concern that implementation of work orders or **HS** requirements would unreasonably compromise the safety or health of an individual or the environment, such a concern should be brought **to** the attention of an immediate supervisor, the SSHR, or the FS. Field team personnel involved in the on-site execution of the construction activities are responsible for the following:

- taking all reasonable precautions to prevent injury to themselves and to their fellow employees, being alert to potentially harmful situations;
- performing only those tasks for which they have been trained and believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSHR and/or the line managers;
- notifying the SSHR of any special medical conditions (i.e., allergies, contact lenses, pregnancy, diabetes) and, if necessary, ensuring that all on-site personnel are aware of the condition;
- preventing spillage to the extent possible and, in the event spillage occurs, containing the spillage and cleaning up immediately using safe cleanup measures as directed by the SSHR;
- practicing good housekeeping by keeping the work area neat, clean, and orderly to the extent possible;
- reporting all injuries;
- abiding by requirements of this ES&HP and all applicable radiological work permit (RWP) requirements; and
- following **ISMS** philosophy by informing the project management of any safety/process improvement opportunities.

4.6 RADIOLOGICAL CONTROL ORGANIZATION (RADCON)

BJC will develop controls for radiological hazards associated with project tasks. These controls will be documented in RWPs. **BJC**'s radiological control subcontractor will provide support in the field by providing radiological control technicians (RCTs) to implement these RWPs. The RADCON responsibilities include the following:

- preparing and closing out RWPs;
- stopping work activity and revising the site RWP when the radiological controls required do not provide adequate worker protection or contamination control;

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- providing guidance on radiological decontamination of equipment and personnel; and
- performing radiological surveys as needed.

4.7 SITE VISITOR

A visitor (e.g., regulatory personnel, field auditors, etc.) is anyone who arrives at the work site who is not identified as a field team member or associated support personnel in the project-specific documents. When a visitor arrives, the **FS** or his/her delegate is to ascertain the purpose of the visit and inform the visitor(s) of any hazards, applicable protective controls, and the emergency response procedures relevant to the site visit.

Visitors are not permitted to enter controlled work zones where access has been limited unless absolutely necessary. In such cases, the visitor shall be briefed, shall meet all applicable requirements of the ES&HP, and may need to be accompanied by an escort at the discretion **of** the SSHR. If a visitor does not comply with these requirements, the FS or SSHR, or his/her delegate, shall request the visitor to leave the controlled zone immediately or shall limit site operations to minimize threat of harm to the visitor (e.g., have the field team take a break, reset the zone boundaries if appropriate, or temporarily discontinue any threatening task).

5. MEDICAL SURVEILLANCE

Before the **FS** authorizes access to areas of the site where site controls have been established [e.g., exclusion zone (EZ), contamination reduction zone (CRZ), and OSHA-regulated areas], it must be verified that personnel entering such areas have a current certification of medical evaluation and clearance in compliance with **OSHA,** DOE, and BJC requirements.

- Copies of clearance documents will be maintained on-site.
- All personnel shall have a current HAZWOPER clearance on file before entering the EZ.
- All personnel that may be required to wear a respirator (including as an evacuation aid) shall have a current respirator medical release and current fit certification prior to entering the EZ.
- All personnel exposed to noise at greater than 85 dB shall receive annual audiograms.
- All personnel who have the responsibility of rendering first aid shall have cardiopulmonary resuscitation (CPR)/first aid, blood-borne pathogens training, and shall receive hepatitis B vaccinations or will have declined the vaccination. Records of this training will be kept on-site.
- All personnel required to submit a baseline bioassay by a RWP shall have done so before entering the radiological control area.

6. HAZARD COMMUNICATION AND TRAINING

OSHA Standard 29 *CFR* 1910.1200, "Hazard Communication Standard," requires that all employees handling or using hazardous materials or potentially hazardous materials be advised and informed as to the hazard potential associated with those materials. This training will be documented, and additional information will be conveyed through the following items.

6.1 MATERIAL SAFETY DATA SHEETS

Copies of all MSDSs for chemicals brought on-site will be maintained on-site by the FS and will be readily available. Each employee is to be made aware of the location of the MSDSs.

6.2 CHEMICAL INVENTORY

A list of all chemicals brought on the site will be maintained by the FS. A hazardous material inventory system physical inventory form (including copies of **MSDS** forms) must be submitted to the BJC STR before operations begin and by the end of each month.

6.3 LABELS

It is the responsibility of the **FS** to ensure that all potentially hazardous materials brought to a project site are properly labeled [per 29 *CFR* 1910.12001 as to the contents of the container and the appropriate hazard warnings (including effects on target organs).

6.4 PACKAGING, LABELING, HANDLING, TRANSPORT, STORAGE, AND DISPOSAL OF HAZARDOUS SUBSTANCES

- Requirements and procedures for packaging, labeling, handling, transport, and/or disposal of hazardous materials and wastes shall be specified in the site-specific waste management plan.
- Procedures shall meet applicable OSHA requirements of 29 *CFR* 1926.65, 1926.152, and applicable standard(s) in Subpart Z of 29 *CFR* 1926 or 1910 for the substance(s) that are deemed of occupational health concern in the AHA.
- Procedures also shall meet applicable **U.S.** Department of Transportation (DOT) requirements (49 *CFR* 106,107,130, and 171–180).
- Hazardous substances shall be transported in accordance with relevant DOT requirements (49 *CFR),* including certification and registration of drivers (49 *CFR* 107 Subpart *G).*
- Hazardous wastes shall be labeled, stored, and inspected in accordance with 40 *CFR* Subtitle C.

7. SITE CONTROL MEASURES

The necessary site-specific control measures shall be indicated in this ES&HP and the AHA(s), some of which are required by applicable DOE and OSHA standards (i.e., the OSHA HAZWOPER standard and 29 *CFR* 1910 and 1926 Subpart Z standards). Site maps required by OSHA shall also be included in this ES&HP (see Attachment D) for HAZWOPER projects to show the intended locations of the specified controlled access zones and support facilities. DOE states (DOE **HS** plan guidelines)] that, among other items, site maps should include: ***(References Exhibit*** G ***matrix; ISMS Item 5, includes all of Sect. 7 Site Control Measures.)***

- site perimeter, prevailing wind direction, and drainage points;
- natural and man-made features such as buildings, containers, impoundment, pits, ponds, and tanks; and
- locations of work zones and/or contamination containment barriers.

Since some zone or facility locations may change as site work progresses, current locations of zones and decontamination stations must be explained to field team members and other affected personnel during **HS** tailgate meetings and documented.

Descriptions of site controls shall indicate whether a zone or facility is restricted as a radiological control area, a radioactive materials management area, or an OSHA-regulated area, and the related access control and hazard posting requirements. Whether the location **of** a facility is centralized on-site or localized at multiple work areas on-site, the means for demarcating each zone, and other posting requirements, also shall be indicated. Postings must comply with applicable OSHA, American National Standards Institute (ANSI), and BJC Radiation Protection Program requirements.

7.1 ENGINEERING AND ADMINISTRATIVE CONTROLS

As a first line of defense, DOE and **OSHA** require that employers implement engineering and/or administrative controls to prevent and/or mitigate hazards and protect site personnel. Secondly, employers may require employees to use personal protective equipment (PPE). This section addresses the basic engineering and administrative control requirements with which **SPH** participants are required to comply. Guards and site-specific engineering and administrative requirements corresponding to the task-specific hazard assessments shall be included in the AHA.

7.2 ACTIVITY HAZARD ASSESSMENT

An AHA shall be prepared for each field activity (task) to be performed before the activity is conducted. Each hazard analysis shall be site-specific and have two essential components: (1) identification and assessment of the hazards associated with performing each task at each site, and (2) determination of the necessary and sufficient controls for preventing or mitigating the anticipated hazards and adequately protecting affected personnel.

For each task to be performed at the project site, the hazards shall be identified and assessed by personnel experienced in the type of task to be performed to determine the associated qualitative probability of occurrence and the severity of injury/ illness expected to result. The assessment shall address the site- and task-specific hazards that could result from exposure to radiological, safety, biological, physical, and chemical hazards. Based on the hazard assessment, the corresponding protective and control measures are to be determined. The site- and task-specific hazard assessments and controls are to be incorporated into the ES&HP. (See Attachment **A.)** ***(References Exhibit*** G ***matrix; ISMS Items 2, 3, 4, and 5.)***

7.3 SITE-SPECIFIC PERMITS

Safety and health work permits for work conducted will be issued by BJC. Permits that may be required include a safety and health work permit, RWPs, hot work, and excavation/penetration permits. The STR will coordinate implementation of the permit before performing field activities. The SAIC team will be fully aware of its responsibilities for work performance under these permits.

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7.3.1 Applicability

The following permits and/or procedures apply as necessary to field operations:

- Excavation—TS participants are required to apply for a PGDP excavation permit in accordance with CP2-SH-IS1045, "Trenching, Excavation, and Penetration Permit," for any excavating (ground brealung) or trenching operation. Any such operations that will penetrate subsurface soil by greater than 6 inches in depth also will require completion of the AHA review process. Compliance with the PGDP electrical safety requirements (excavation/penetration permit) is required for any activity involving penetration or excavation into walls, ceilings, floors, masonry surfaces, slabs, ground surfaces, or other structures.

- **Lockout/tagout** of hazardous energy sources—As required by 29 *CFR* 1910.147 (Hazardous Energy Control Procedure) and CP2-SH-IS1065, "Instructions for Lockout/Tagout."

- **RWPs**—As required by BJC Radiological Protection Program (RPP).

- **Spark/flame-producing** operations (hot **work/burn** permit)—TS participants must comply with CP2-SS-FS1031, "Welding, Burning, and Hot Work Permit," for a special work permit for spark/flame-producing operations.

7.4 ESTABLISHMENT OF WORK ZONES

The following is a description of the different types of zones that will be established at the site.

- **EZ**—the area where work is being performed and chemical, physical, and/or radiological hazards exist. Entry into this area is controlled and the area clearly marked with barrier tape. Unauthorized entry into these areas is strictly prohibited. Permission to enter the EZ is granted by the SSHR.

- **CRZ**—the area between the EZ and the support zone. It serves as a buffer to reduce the possibility of the support zone becoming contaminated. It is also the area where decontamination of personnel and equipment is conducted.

- Support **zone**—the area outside of potential contamination. This zone serves as an administrative area, a storage area for noncontaminated equipment, a break area, and an area for the consumption of food and beverages.

7.4.1 Prohibited Activities

The SSHR shall ensure individuals are removed from the site for violations of any activities prohibited in the EZ and CRZ. The following activities are prohibited:

- eating, drinking, smoking, chewing, and applying anything to the face,
- horseplay,
- removal of respiratory protection while working in areas that require Level C PPE or higher,
- personal items (rings, watches, earrings, jewelry, etc.) that compromise the effectiveness of required PPE, and
- entry into work areas without the appropriate training.

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7.5 PERSONAL SAFETY

The following paragraphs cover some of the many personal safety issues. Also refer to the AHAs.

Hearing Protection. Any noise exposure in excess of 85 dB for a time-weighted average for an 8-h day requires the use of hearing protection. If employees encounter noise sources they feel are hazardous to their hearing and the sources have not been evaluated, the employees are required to contact the SSHR so he/she may evaluate the noise levels and recommend appropriate hearing protection, if required. For all noise sources identified as hazardous, employees are required to wear the prescribed hearing protection properly per the AHA.

Each employee receives an audiogram during his or her annual physical. The results from this test are compared to the employees' baseline (if first annual exam) or compared to past test results. As part of the SAIC hearing conservation program, the SSHR will follow the permissible noise exposure guidelines as listed in 29 CFR 1910.95 or 29 CFR 1926.52.

Eye Protection. Eye and face protection requirements are contained in the site-specific AHA. If field conditions change and warrant more or less protection than is listed in the site-specific AHA, the SSHR will determine what protection is necessary. Determination of eye and face protection will follow the guidelines of 29 *CFR* 1926. Safety glasses with side shields will be the standard eye protection in work areas.

Biological Hazards. The most common biological hazards encountered by workers will be flying insects, ticks (dog and deer), and chiggers. Employees should avoid nests containing flying/stinging insects; however, if removal of a nest is necessary, contact the SSHR for assistance. If an employee is allergic to stinging insects, notify the SSHR to ensure adequate protection.

- At the end of the work day, employees should examine themselves for ticks. If the employee is in an area where tick infestation is possible, proper PPE should be worn. Examples of personal protection include long sleeves, taping pant cuffs to boots, and using duct tape to capture moving ticks.

At some work locations, there will be a possibility of encountering poisonous plants. If the employee is exposed to these plants, the affected area will be washed immediately with soap and water. The SSHR will be notified if medical attention is needed.

Ergonomics. Repetitive movement is not anticipated as a hazard for tasks on this project.

Safe Lifting Practices. When it is necessary to lift objects, follow the listed safety lifting practices. **A** single individual my not lift more than 50 lb without assistance. If an object weighs 50 to 120 Ib, two or more workers are required to perform the lift. If the object is large or awkward (i.e., sample coolers, equipment), more people may be needed to lift it. Clear a pathway before moving the object. If possible, use carts, hand trucks or powered lifting equipment to move the object. Bend knees and keep back straight. Get the object as close to the body as possible and lift with the legs.

Hand and Power Tools. All hand and power tools and similar equipment, whether furnished by the employer or the employee, will be maintained in a safe condition.

Guarding. When power-operated tools are designed to accommodate guards, they will be equipped with such guards when in use. Belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts of equipment will be guarded if such parts are exposed to contact by employees or otherwise create **a** hazard. Guarding will meet the requirements as set forth in ANSI B 15.1-1953 (R1958), "Safety Code for Mechanical Power-Transmission Apparatus." One or more methods of machine

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guarding will be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ongoing nip points, rotating parts, flying chips, and sparks. Examples of guarding methods are barrier guard, two-hand tripping devices, and electronic safety devices.

7.6 STOP-ACTIVITY AND STOP-WORK ORDERS

At all times during the performance of work under this project all project participants have the responsibility to exercise "stop work" authority. This authority can be exercised when any employee observes the condition of "imminent danger" at the work site. Imminent danger means a condition or hazard that would reasonably be expected to cause death or serious harm to workers or members of the public immediately before such condition or hazard can be eliminated through normal practices. Should an employee exercise this right at a work site for this operation, the SSHR shall be notified immediately. The name and badge number of the employee exercising this right will be obtained and given to the **SSHR.**

7.7 RESPIRATORY PROTECTION

Respiratory protection is not anticipated for the scope of this project. If conditions warrant the use of respirators, the requirements of the SAIC written respiratory program will be met, along with the requirements of OSHA and ANSI. The AHA provides information on types of respirator equipment to be used if conditions warrant respiratory protection.

7.8 HEAT STRESS AND COLD INJURY

The most common types of stress that affect field personnel are from heat and cold. Heat stress and cold stress may be the most serious hazards to workers at waste sites. In light of this, it is important that all employees understand the signs and symptoms of potential injuries associated with working in extreme temperatures. Refer to "Heat Stress and Cold Injury," Attachment B.

7.9 HOUSEKEEPING AND SANITATION

- *An* adequate supply of potable water shall be provided in labeled container(s) that are equipped with a tap and capable of being tightly closed. Nonpotable water outlets shall be identified to indicate that the water is unsafe for drinking, washing, or cooking.
- No food, beverage, gum, cosmetic, or tobacco products shall be present, consumed, or used in any region of a work zone where contamination is suspected.
- Work zones will be cleaned and wastes and debris will be removed daily. Tools, materials, welding leads, hoses, or debris will not be strewn about in a manner that may cause tripping or other hazards. Stored material will be placed and stacked in a manner that is stable and otherwise secured against sliding or collapse. All slip, trip, and fall hazards will be eliminated.

7.10 FALL PROTECTION AND FALL PREVENTION

To protect personnel from injury during elevated work activities, the following fall protection and fall prevention practices will be enforced. Fall protection/prevention activities will comply with BJC Procedure BJC-EH-2003, Elevated Work/Fall Prevention.

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7.10.1 PGDP Fall Protection Policy

100% fall protection will be maintained at all times when personnel are working at heights of *6* ft or above. This means that workers will not be permitted to perform duties in areas where falls are possible without being adequately protected. Fall protection and prevention will consist of one or more of the following:

- preventing a fall by installing adequate guard rails;
- restricting entry into a fall hazard area by use of barricades, barriers, or warning flags; and
- protecting workers by using fall protection equipment (e.g., full body harness and shock-absorbing lanyards) to arrest falls.

7.10.2 Fall Arrest Equipment

- A full body harness and lanyard are required for unprotected work at heights of *6* ft or above.
- A twin lanyard system will be used any time an individual must unhook a lanyard for movement while working unprotected at heights of *6* ft or above.
- All full body harnesses will be Class C, approved by ANSI.
- All lanyards will be shock absorbing and will have double-locking snap hooks that prevent rollout.
- Personnel at unprotected elevations will be tied off to lifelines attached to structures that can support at least 5000 lb of dead weight per employee.
- All fall protection equipment will be inspected before each use. Lanyards and harnesses will not be used if evidence of damage is present. All hardware must be examined, and worn parts must be replaced.
- Harnesses and lanyards must be removed from service if used in a fall.

7.10.3 Ladder Inspection and Use

- Ladders with broken or missing rungs or steps, broken or split rails, or other faulty or defective construction, will be tagged “Defective Do Not Use” and will be removed from the job site.
- All extension ladders will be tied, blocked, or otherwise secured to prevent them from being displaced.
- Ladders will be placed on a firm, level base; the areas around the tops and bottoms of the ladders will be kept clear.
- When ladders are used to access platforms or working surfaces, the side rails will extend at least **3** ft above the landing.
- Personnel will always face a ladder when ascending or descending.
- Personnel will always have free use of both hands and feet to firmly grasp the ladder while ascending or descending. Such free use of the hands will preclude the use of fall protection during ascent or descent only.

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7.10.4 Training

All personnel who may be exposed to fall hazards during their work duties will be trained in elevated work/fall protection and prevention before starting those duties on-site.

7.11 WORKING SURFACES

- All areas will be kept clean, orderly, and sanitary.
- At no time will employees be allowed to climb the mast of a drill rig while it is in the upright position.
- Care will be taken to avoid slips/trips while working on uneven, wet, or plastic-covered surfaces.
- Head protection will be required while working under pipes or around protruding objects.

7.12 HOISTING AND RIGGING PRACTICES

SAIC shall comply with the latest revision of the BJC hoisting and rigging procedure, BJC-EH-2008.

In order to ensure that personnel are not injured or equipment is not damaged during hoisting and rigging operations, the following safe working guidelines will be enforced. These guidelines include those outlined in **OSHA** and DOE hoisting and rigging manuals. A person competent in hoisting and rigging will be on-site during all lifting activities. For these activities, the person will be the **SSHR** or designee.

7.12.1 General

All hoisting and rigging activities will be reviewed to determine their classification according to the definitions provided below:

- Nonroutine lift: Parts, components, assemblies, or lifting operations for which dropping, upsetting, or collision of items could do any of the following:

  — cause significant work delay,

  — cause undetectable damage resulting in future operational or safety problems,

  — result in significant release of radioactivity or other serious and undesirable environmental conditions, or

  — present a potentially unacceptable risk of personal injury or property damage.

- Routine lift: Any lift not designated as a nonroutine lift

All lifts on this project are expected to be routine. Before all routine lifts, the qualified hoisting and rigging inspector will complete a hoisting and rigging checklist, and it will be maintained on the job site for review. If an added scope of work requires a nonroutine lift, a separate hoisting and rigging plan will be developed and presented to the SAIC Lift Committee chairman for review and approval before the lift proceeds.

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7.12.2 Hoisting

Only designated and qualified personnel will operate hoisting equipment. Hoisting operators will be in visual or radio contact with a flag person before and during every lift. If visual or radio contact is interrupted for any reason, the operator will stop the lift until full contact is restored.

- The equipment will be capable, within the manufacturer's specifications, of fulfilling all requirements of the work without endangering personnel or equipment.

- Equipment with outriggers will have the outriggers fully extended and set before all lifts.

- Before lifting, operators will know the total weight of the load, including the following:

  - actual weight of the load and all packaging materials; and

  - rigging and any associated slings, shackles, chokers, and rings; and load line hook, headache ball, and wire rope.

- The operator will check the load line brake and the crane for stability when the load is only inches from the ground, before proceeding with any lift. This lift of a few inches will be considered a "trial lift."

- A suspended load will never be left unattended. An operator will not leave the control station of a crane during a lift except under the conditions listed below:

  - The load is lowered or raised to a safe landing area with no tension on the load line,

  - After all brakes, pawls, switches, and clutches are properly positioned, control of the crane is transferred to another qualified operator, or

  - The load is supported by other means such as cribbing, manufacturer's sleds or frames, suspended rigging, or another crane.

- The hoist line will be vertical at all times.

- Personnel will not stand or pass under suspended loads.

- A tag line(s) will be required on all loads. As many tag lines as necessary will be used to adequately control the load while landing.

- A crane load chart for the crane, as configured, will be posted in the cab of each crane, as will the rated load capacities, recommended operation speeds, and special hazard warnings or instructions.

- Cranes will be inspected in accordance with the guidelines provided below.

- Applicable ANSI B30-series daily, monthly, quarterly, semiannual, annual, and special inspections will be completed before any crane is operated.

  - **A** qualified inspector following the manufacturer's recommendations and specifications will complete all inspections.

- The annual certification sticker will be prominently displayed on the crane, but in such a manner that it does not obstruct the operator's view of any work operation.

- Borrowed, rented, or leased cranes will be inspected before on-site use by the qualified crane inspector regardless of any other signed inspection forms.

7.12.3 Rigging

- Rigging equipment for material handling will be visually inspected before use and as necessary during its use to ensure that it is safe. Defective rigging equipment will be removed from service and repaired or destroyed. All rigging equipment will be load-tested at least annually by a competent person who, by training or experience, can recognize defects and take appropriate action to correct them.

- Rigging equipment will not be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 of OSHA 29 *CFR* 1926 Subpart **H** (29 *CFR* 1926.251, "Rigging Equipment for Material Handling").

- Special hoisting devices, slings, chokers, hooks, clamps, or other lifting accessories will be marked to indicate the safe working loads and will be proof-tested to 125% of their rated load before initial use.

- The following forms (located in Attachment E) will be used for the inspection of rigging equipment:

  - Wire Rope Inspection,
  - Sling Inspection,
  - Inspection for Chain Hoisting Devices, and
  - Inspection of Metal Plate Clamps.

7.12.4 Training

All personnel involved in hoisting/rigging activities will attend an 8-h hoisting and rigging safety awareness training course before performing hoisting/rigging activities.

7.13 PINCH POINTS AND CRUSHING HAZARDS

Work areas around heavy equipment necessitate controls to avoid pinch points and crush injuries. When employees are working in areas where heavy equipment is being operated, the SSHR will institute controls such as the following (this list is not all inclusive):

- flagging off-work zones to keep out unnecessary and untrained personnel;

- keeping area clean of unnecessary equipment;

- ensuring equipment has backup alarms, and using spotters when equipment is being loaded, unloaded, or working in close quarters.

Another pinch-point hazard is opening and closing drum lids. Employees need to know the site-specific procedures regarding safe opening and closing of sealed drums.

7.14 EXCAVATION AND TRENCHING

The BJC has the responsibility for preparing and issuing an excavation/penetration permit before any excavation, removal, or penetration operations are performed to control hazards from buried utilities.

The STR will obtain an excavation permit before any excavation or penetration below *6* inches. The excavation permit process ensures that no underground utilities or structures will be encountered. The SAIC team will not perform any work that penetrates the ground more than *6* inches before this permit is issued.

7.14.1 Lockout/Tagout

To ensure the safety of personnel working on equipment or systems, PGDP safe practices and SAIC procedures will be followed for lockout/tagout. The purpose of these procedures is to prevent the release of potentially hazardous energy during maintenance or service activities. Lockout/tagout procedures apply to energy sources that could cause injury to personnel from the unexpected energization or release of stored energy while participating in such activities as—but not limited to—installing, constructing, repairing, adjusting, inspecting, testing, or maintaining systems or equipment. The procedures apply to forms of potentially hazardous energy, both latent and residual, including electrical, hydraulic, pneumatic, mechanical, chemical, and radioactive.

7.15 MOTOR VEHICLES AND MECHANIZED EQUIPMENT

7.15.1 High-Profile Equipment

High-profile equipment may be operated and will be located in a manner to ensure that no part of the equipment will be within 10 ft of energized circuits. All equipment operations that take place in the area of high-voltage power lines and that are capable of contacting the lines while in operation or in transit will be accompanied by a qualified observer, positioned outside the equipment, who can observe and give timely warning to the operator to prevent an accident or encroachment into the 10 ft minimum clearance zone. When equipment is in operation near energized lines, the equipment will be grounded. Operators of this equipment should be able to demonstrate proof of qualifications.

7.15.2 Equipment Inspection

All vehicles/heavy equipment brought on DOE property are required to be inspected before entry. The STR may conduct the inspection at the equipment staging area. Periodic safety inspections may be conducted on all vehicles and equipment by the STR, or his/her designee, and all vehicles will be in compliance with DOT requirements. Operators will perform daily equipment and vehicle inspections prior to operation. All equipment left unattended at night, adjacent to a roadway in use or adjacent to construction areas where work is in progress, will have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment. A safety tire rack, cage, or equivalent protection will be provided and used when inflating, mounting, or dismounting tires installed on split rims, or rims equipped with locking rings or similar devices.

Heavy machinery, equipment, or parts thereof, which are suspended or held aloft by use of slings, hoists, or jacks will be substantially blocked **or** cribbed to prevent falling or shifting before employees are permitted to work under or between them. Bulldozer and scraper blades, end loader buckets, dump bodies, and similar equipment either will be fully lowered or blocked when being repaired or when not in use. All controls will be in a neutral position, with the motors stopped and brakes set, unless work being performed requires otherwise. Whenever the equipment is parked, the parking brake will be set. Equipment parked on inclines will have the wheels chocked and the parking brake set.

7.15.3 Fork-Lift Use

All fork-lift activities will be conducted in accordance with MAS-030 and 29 *CFR* 1926.602(c), "Lifting and hauling equipment." Operators must have completed OSHA compliant training.

7.16 FIRE HAZARDS

7.16.1 General

Only approved metal containers equipped with spark arresters and portable tanks will be used for the storage and handling of flammable and combustible liquids. Approved safety cans or DOT-approved containers will be used for handling liquids in quantities less than five gallons.

7.16.2 Storage of Flammable and Combustible Liquids

Flammable and combustible liquids will not be stored inside any of the facility buildings. All flammable and combustible liquids in excess of a single 5-gal safety can will be stored in properly grounded steel flammable storage cabinets located on-site. The steel cabinets will be clearly labeled as fire hazards as required by local and industry standards. A maximum of three steel cabinets will be collocated. Each steel cabinet will contain less than 60 gal of flammable or 120 gal of combustible liquids. One portable fire extinguisher (rated not less than 20-B units) will be located at the construction trailer next to the front entrance (not less than 25 ft nor more than 75 ft from the flammable and combustible storage area). Any flammable or combustible liquid, which cannot be placed in the steel cabinets, will be stored in accordance with OSHA regulations.

7.16.3 Dispensing Liquids

Vehicles and large equipment (i.e., drill rigs) and small equipment (generators, mowers, and weed eaters) may be refueled on-site; however, the following requirements/guidelines must be met.

- Refueling will be performed using approved vessels, containers, or tanks.
- Refueling will be performed only after the equipment has been turned off and allowed to cool for 3 min.
- **A** spill kit must be available to control spills should they occur.
- No source of ignition, including spark-producing tools, will be permitted within 50 ft of refueling operations.
- The transfer of flammable liquids will be done only when the containers are electrically interconnected/ grounded.

7.16.4 Oil/Cleaning Rags Storage

Used oil and cleaning rags will be stored in a 55 gal steel drum at least 25 ft from operating areas and sources of ignition. The drum will be clearly marked and the lid in place at all times.

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7.17 ELECTRICAL HAZARDS

7.17.1 Safety Training

Employees who face a risk of electncal hazard that is not reduced to a safe level by the electrical installation requirements will be trained to understand the specific hazards associated with electrical energy. They will be trained in safety-related work practices and procedural requirements as necessary to provide protection from the electrical hazards associated with their respective job or task assignments. Employees will be trained to identify and understand the relationship between electncal hazards and possible injury.

Employees working on or near exposed energized electrical conductors or circuit parts will be trained in methods of release of victims from contact with exposed energized conductors or circuit parts.

7.17.2 Working on or near Electrical Conductors or Circuit Parts

Safety-related work practices will be used to safeguard employees from injury while they are working on or near exposed electncal conductors or circuit parts that are or can become energized. The specific safety-related work practice shall be consistent with the nature and extent of the associated electrical hazards.

Exposed energized electrical conductors or circuit parts to which an employee might be exposed will be put into an electrically safe work condition before an employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

An electrically safe work condition will be achieved and verified by the following process:

- determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- after properly interrupting the load current, open the disconnecting device(s) for each source.
- where it is possible, visually verify that all blades of the disconnecting devices are fully open or that draw-out type circuit breakers are withdrawn to the fully disconnected position.
- apply lockout/tagout devices in accordance with a documented and established policy.
- use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Before and after each test, determine that the voltage detector is operating satisfactorily.

·Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground-connecting devices rated for the available fault duty.

7.17.3 Underground Hazards

Underground hazards occur when underground installations are encountered during drilling or excavation work. These structures may include gas utilities, power lines, product lines, concrete vaults, and tanks. These present a potential for electrocution, explosion, spills or releases, or injuries to the field personnel. *An* Excavation/Penetration Permit will be obtained prior to activities that will penetrate more than **6** inches below the ground surface.

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BJC is responsible for generating the Excavation/Penetration Permit. A pre-excavation meeting will be held to review the Excavation/Penetration Permit and work area to ensure all underground installations have been identified. Should an underground object be hit during field activities, the field crew will move away from the area and the STR shall be notified to assess the situation.

7.17.4 Overhead Hazards

Table C.3 shows the minimum clearance booms and towers are to maintain from energized overhead lines.

Table C.3. Energized overhead line safe distance

Nominal system voltage	Minimum rated clearances
0 to 50 kV	3 m
51 to 200kV	4.5 m
201 to 300 kV	6 m
301 to 500 kV	7.5 m
501 to 750 kV	10.5 m
751 to 1000 kV	13.5 m

8. EXPOSURE MONITORING

Site-specific exposure monitoring strategies (including action levels and the actions triggered) that meet applicable DOE and OSHA requirements shall be specified in the ES&HP for each project task having associated requirements. Exposure monitoring strategies should be determined based on the hazards that can be monitored using analytical instrumentation and the published exposure limits and physical, chemical, and toxicological properties of the chemical and/or radioactive substances of concern.

8.1 INSTRUMENTS, METHODS, AND CALIBRATION

Exposure monitoring generally includes use of direct-reading instruments, personal dosimetry, and personal and area sampling, as necessary, to evaluate the hazardous conditions posed by the chemical and radiological substance on-site. In accordance with DOE and OSHA requirements, the following information shall be specified in the AHA for each type of monitoring instrument to be used for exposure monitoring:

- locations and frequencies of monitoring
- corresponding action level(s), response actions, and rationales

Results of exposure monitoring must be documented, and affected personnel must be informed of these results in accordance with the requirements.

The site has the potential for exposure to contaminants described in Table C.4. The only contaminant with the potential to be present in hazardous concentrations is TCE. The other contaminants have been found in trace amounts. Likely exposure routes include inhalation of vapors and dermal contact with contaminated water, mud, or soil. Proper use of PPE and attention to personal hygiene (e.g., washing hands before eating or smoking, etc.) can prevent oral ingestion and limit the potential for exposure.

In addition, a potential exists for exposure to various substances used in the course of the work (Table C.5). These include gasoline, hydraulic, and lubricating oils. These can be found in Attachment F (MSDSs).

Table C.4. Potential exposure to contaminants

Compound	Symptoms	PEL	TLV	REL
Benzene	Irritated eyes, nose, respiratory system; giddiness; nausea, staggered gait; carcinogen	OSHA: 3000ppm IDLH 1 ppm 8h TWA 5 ppm STEL	ACGIH: 10 ppm 8 h TWA	NIOSH: 0.1 ppm 8 h TWA 1ppm STEL
Carbon Tetrachloride	CNS depressant; nausea, vomiting; liver, kidney damage; skin irritation; carcinogen	OSHA: 300 ppm IDLH 2 ppm 8 h TWA	ACGIH: 5 ppm 8 h TWA	NIOSH: 2 ppm 8 h TWA
TCE	Irritated eyes and skin, vertigo, visual distortion, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury, carcinogenic	OSHA: 1000ppm IDLH 100 ppm 8 h TWA 200 ppm ceiling 300 ppm (5-min max peak in any 2 h)	ACGIH: 50 ppm 8 h TWA 100 ppm STEL	NIOSH: 25 ppm 8 h TWA
Vinyl Chloride	Weakness; abdominal pain, GI bleeding; hepatomegaly; pallor or cyanosis of extremities; carcinogen	OSHA: 1 ppm 8 h TWA 5 ppm ceiling	ACGIH: 5 ppm 8 h TWA	NIOSH:

ACGIH = American Conference of Governmental Industrial Hygienists
IDLH = immediately dangerous to life or health
NIOSH = National Institute for Occupational Safety and Health
OSHA = Occupational Safety and Health Administration
PEL = permissible exposure limit
REL = recommended exposure limit
STEL = short-term exposure limit
TCE = trichloroethene
TLV = threshold limit value
TWA = time-weighted average

Table C.5. Potential exposure to other substances

Hazard or measured parameter	Area	Interval	Limit	Action	Tasks
TCE, and other organics with photoionization detector	Breathing zone (2 to 3 ft from source or 14 inches in front of employee's shoulder)	Continuously during drilling activities	>5 ppm on a sustained basis or short duration readings >25 ppm	Withdraw and evaluate: Identify contaminants	Drilling operations
TCE, benzene, and vinyl chloride Personal Sampler	Breathing zone ("lapel" mounted collector tube)	Continuously during drilling activities and during startup of treatment	TWA exposures >PEL	Withdraw and evaluate	Drilling Operations and Treatment Operations
Radiological contaminants survey instruments	Surface of materials	Spot checking during drilling activities	<2 mrem/h	Notify Health Physics if twice background	Drilling operations
Heat Stress Aural (ear) thermometer	Within the ear	Representative of the working conditions during the hottest part of the day/shift	If exceeds 99.6 °F (100.4°F core)	Shorten the next work cycle by one-third	All operations
Temperature Extremes Wet-bulb globe temperature	Humidity and air movement, radiant heat, and air temperature	During work shift	Refer to Attachment B of this document	Refer to Attachment B of this document	All operations
Noise Sound Level Monitor	Hearing zone within 3 ft of source	During work shift	>85 dB for an 8-h TWA	Any noise exposure in excess of 85 dB requires the use of hearing protection	Drilling operations

mrem = millirem
PEL = permissible exposure limit
ppm = parts per million
TCE = trichloroethene
TWA = time-weighted average

8.2 ANALYTICAL LABORATORY REQUIREMENTS

The American Industrial Hygiene Association should accredit analytical laboratories that analyze samples for chemical contamination for OSHA compliance purposes. All samples shall be analyzed in accordance with the appropriate National Institute for Occupational Safety and Health or OSHA methodology or a method deemed equivalent by the laboratory.

9. RADIATION SAFETY PLAN

The SAIC team will operate under BJC's DOE-approved RPP when performing activities on work releases (WRs) where a potential hazard is posed by radiation exposure. The SAIC team will support BJC in assessing radiological hazards that may be encountered. This has been primarily accomplished through the preparation of this ES&HP and an AHA (Attachment **A).** Based on these evaluation activities, appropriate engineering, administrative, and PPE controls will be selected and implemented. Whenever possible, work will be arranged to avoid (or at least minimize) entry into radiological areas. The radiation safety work practices focus on establishing controls and procedures for conducting work with radioactive material while maintaining radiation exposures ALARA.

The SAIC team will conduct all work associated with radiological issues in accordance with the BJC RPP, and, that as a result, BJC will provide radiological support services for WR activities with potential radiation exposure. BJC may provide RCTs to perform surveys and monitoring, coordination of dose assessments, identification of radiological areas, and the preparation of RWPs. The SAIC team will implement and maintain any controls identified as a result of these services.

9.1 SAIC TEAM RESPONSIBILITIES

SAIC team responsibilities, in coordination with BJC, may include the following:

- Providing and erecting any radiological barriers, barricades, warning devices, or locks needed to safely control the work site.
- Following the requirements of the BJC RWPs, including daily briefings, and requirements for signing in on all RWPs.
- Submitting bioassay samples and using external dosimeters.
- Notifying BJC in advance of work shift changes, work schedule changes, or special radiological survey needs that require an increase in the number of RCTs assigned to the project.
- Notifying the BJC STR within three worlung days after a SAIC team employee declares a pregnancy.
- Establishing radiation control measures that comply with the requirements specified by the BJC radiological personnel supporting the project.
- Determining required radiological PPE based on SAIC team work processes and AHAs.

9.2 SITE-SPECIFIC RADIATION SAFETY WORK PRACTICES

The SAIC team will implement the following radiation safety work practices.

- SAIC team personnel will adhere to the action levels and hold points identified in the RWP addressing the potential radiological hazards posed by work activities under this WR. Work practices and PPE will be altered according to changing radiological requirements as prescribed by the RWP and/or the BJC RADCON.

- All work activities to be performed under this WR will be designed and performed ensuring minimization of material brought into the Radiological Areas. Management, design engineers, and field personnel will jointly identify the materials and equipment needed to perform this work. Only equipment and supplies necessary to successfully accomplish the various tasks to be performed under this WR will be taken into the EZ. Work also will be planned and conducted in a manner that minimizes the generation of waste materials. All activities will be designed, prior to commencement of field activity, to maintain radiation exposures and releases **ALARA.** Emphasis will be placed on engineering and administrative controls over the use of PPE, when feasible.

- All personnel working in or subject to work in the Radiological Areas will read the applicable RWP. The SSHR also will verbally review the RWP during the initial prework safety briefing. The **FS** and the **SSHR** will continuously monitor worker compliance with the RWP. The **FS** and/or the **SSHR** will communicate changes to the RWP immediately to all affected personnel and work practices will be changed accordingly. Radiological controls specified by the RWP, such as PPE and work activity hold points, will be reviewed during "tailgate" safety briefings.

- All work will be planned to address the likelihood of encountering radioactive contamination during the drilling phases of this WR and any other ground penetration activities. All drilling debris will be contained by laying plastic sheeting on the ground under and around the drill rigs. Investigation-derived waste (IDW) will be shoveled into waste drums as it is generated.

- All SAIC lower-tier subcontractors will be required to read and comply with this radiation safety plan (RSP) and applicable **RWP.** Applicable portions of this plan will be verbally briefed to field personnel, SAIC team, and lower-tier subcontractors, during the prework safety briefing.

- No radioactive sources will be used for this WR.

- Engineering and administrative controls will be utilized to minimize and control the spread of airborne and surface contamination. If airborne contamination is identified, water mist will be used to eliminate or reduce this hazard. The contaminated water will be contained by plastic sheeting covering the work area. Surface contamination, in the form if IDW, will be containerized in metal drums throughout the drilling process.

- Personnel will be instructed in the proper use and care of external dosimeters prior to commencement of field activities and periodically during prework tailgate briefings. Personnel will be instructed to wear the dosimeters only during activities posing an occupational ionizing radiation exposure. This will include all field activities associated with this WR. Personnel will be instructed to wear their dosimeters outside of company clothing in the front torso area of the body. They are not to expose the dosimeters to excessive heat or moisture. Dosimeters must be exchanged on a quarterly basis.

- SAIC team personnel will participate in the BJC Bioassay Program. All personnel will have submitted a baseline bioassay sample **prior** to receiving an external dosimeter and participating in any fieldwork associated with this WR. Periodic bioassays also will be submitted in a timely manner as directed by BJC RadCon. Personnel not complying with these requirements will be subject to removal from the project.

- The **FS** and the SSHR will conduct a continuous observance of work in progress and of field personnel performance with respect to ALARA. Additional reviews of Performance will be discussed during "tailgate" safety meetings with all field personnel. All lessons learned will be noted in the SSHR's field logbook. Work practices will be modified to incorporate lessons learned. A postjob **ALARA** review will be conducted by the **SSHR** with input from the FS, field personnel, and previous lessons learned recorded in the **SSHR** logbook.

9.3 RADIATION SAFETY TRAINING

The SAIC team will observe the BJC radiological training requirements, which require General Employee Training and Radiological Worker II Training for all employees who will perform hands-on work in radiological areas. The applicability of this training will be determined for each WR assigned under the contract. Personnel, including visitors, who are not necessary to the performance of the WR scope of work and who are not appropriately trained and qualified will not enter any work areas where radiological exposures may occur. In areas where visitors are essential or otherwise approved to be present, they will be restricted from High Contamination Areas, High Radiation Areas, Very High Radiation Areas, or Airborne Radiation Areas. In all other radiological areas, visitors may be present only if escorted by a qualified radiological worker and will perform no hands-on activities.

9.4 REQUIREMENTS APPLICABLE TO RADIOLOGICAL AREAS

The SAIC team will take appropriate precautions and measures to control the potential for spreading contamination from radiological areas into unaffected areas. This will be accomplished by compliance with established site control measures (e.g., use of dedicated equipment, barricades, and signs), preventing **or** minimizing the movement of materials and equipment, monitoring, and decontamination procedures.

The following work zones will be utilized during field activities that have a potential for radiation exposure/contamination.

- **EZ**—the area where work is being performed and chemical, physical, and/or radiological hazards exist. Entry into this area is controlled and the area clearly marked with bamer tape or flagging. Unauthorized entry into these areas is strictly prohibited. Permission to enter the EZ is granted by the SSHR.

- **CRZ**—the area between the EZ and the Support Zone. It serves as a buffer to reduce the possibility of the Support Zone becoming contaminated. It is also the area where decontamination of personnel and equipment is conducted.

- **Support** Zone—the area outside of potential contamination. This zone serves as an administrative area, a storage area for noncontaminated equipment, a break area, and an area for the consumption of food and beverages.

When applicable to WR activities, personnel will mark and secure all hoses and cords crossing the boundaries of Contamination Areas, High Contamination Areas, and Airborne Radiation Areas to help minimize the potential for the spread of contamination and safety hazards. Electrical cords and lines that are not under pressure and do not contain radioactive material will be taped in place and tagged near the end to indicate that external surfaces may be contaminated. Hoses containing water under high pressure

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will be secured, where possible, to prevent whiplash motions caused by loss of operator control. Hoses that may contain radioactive contamination will be conspicuously labeled "CAUTION-INTERNAL CONTAMINATION" or "CAUTION-POTENTIAL INTERNAL CONTAMINATION." Labels or tags will have a yellow background, at least on magenta radiation symbol, and magenta lettering. Labeling is not required on portions of hose inside Radiological Areas. Labels or tags will be placed on opposing sides of the hose, where necessary, to ensure that they are clearly visible from all vantage points and hose positions. At a minimum, labels or tags will be placed every 40 ft along the hose.

Unless otherwise specified by BJC, the SAIC team will procure sufficient tools so that tools frequently required in Radiological Buffer Areas Contamination Control Zones, High Contamination Areas, and Airborne Radiation Areas may be dedicated for that use. These tools will have paint or permanent markings that identify them for radiological work only. When required for a specific WR, the SAIC team will develop and submit a method to control the issuance and use of tools dedicated to these specified areas for review by BJC. In the event that repairs or modifications to tools or equipment are needed, the repairs or changes will be made, where reasonable practicable, in a Non-Radiological Area and/or a portion of the Controlled Area with low levels of contamination.

Work activities will be scheduled to minimize radiation exposures and to prevent idle time in Radiation Areas. Work in these areas will also be coordinated with BJC RCTs to identify locations where lower dose rates exist. These identified locations will be used for performing all work within these areas to the maximum extent possible. Additionally, workers in High Radiation Areas and Very High Radiation Areas will be constantly monitored while in these areas and may require the use of temporary shielding to lower external dose rates.

9.5 WORK ZONE EXIT REQUIREMENTS, DECONTAMINATION, AND CLEANING

When WR activities involve radiological areas, the RWP will provide details on requirements of exiting the work area(s), including personnel and equipment decontamination and cleaning, as appropriate. In many instances, it is anticipated that the BJC will have established procedures for these activities. When this is the case, SAIC team personnel will exit, and monitor in compliance with the BJC requirements. In other situations, appropriate procedures will be developed and observed to control and minimize opportunities for transferring or spreading contamination.

9.6 PERSONNEL

Where required by the WR, procedures for the effective decontamination of personnel also will be implemented. Depending on the potential type and extent of contamination transfer onto personnel, the rigor of these requirements can vary significantly. In some instances, personnel showers may be required. In the even that contamination is found on the worker's skin or clothing, the worker will notify BJC RCTs for decontamination before the individual is permitted to leave the area. If a shower is required, the worker will be transported to a decontamination facility and then reevaluated by the RCTs to ensure removal of the contamination prior to being released.

In any event, the basic sequence of typical decontamination activities will be as follows for personnel exiting a radiological work area (Note: if frisking or other surveying/screening is applicable, appropriate additional steps will be taken):

- Equipment drop (hand-held items) at a designated location,
- Sequential removal of outer protective clothing, and
- Removal of respiratory protection (if worn).

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9.7 WORK ZONE EXIT REQUIREMENTS WHEN SHOWERS ARE NOT REQUIRED

If applicable to the specific WR, when shower facilities are not required, but there is potential for contamination of equipment and personnel, the SAIC team will define an area for decontamination at the exit from Contamination Areas, High Contamination Areas, Radiological Buffer Areas, Contamination Control Zones, Radioactive Material Areas and Airborne Radiation Areas, as applicable. The purpose is to remove ***gross*** contamination from personnel and equipment prior to their exit from the Work Zone and to minimize the spread of contamination outside the Work Zone. The area may include the following materials:

- Step-off pads;
- An equipment drop or storage area for storing reusable PPE (i.e., hard hats) and equipment that does not need to be removed from the Work Zone;
- A boot wash station with brushes;
- Containers for the storage of used respirators (if applicable);
- Containers for disposable clothing (either bags or barrels);
- Chairs or benches or other items may be used for personnel to use while doffing PPE;
- PPE doffing protocol posting; and
- **A** table for portable survey equipment used to survey personnel and their equipment.

Responsibility for providing the above equipment will be as described in the WR scope of work.

Personnel protective equipment (i.e., coveralls, gloves, and boots) will be washed, or removed as appropriate, in the Work Zone to remove gross contamination.

SAIC team personnel will perform a whole-body survey for radioactive contamination before leaving the work zone. Each SAIC team member also will survey personal articles and equipment that will be removed from Radiological Buffer Areas, the Contamination Control Zone, Contamination Areas, High Contamination Areas, and Airborne Radiation Areas. If personnel contamination is detected, the worker will remain in the area and contact the RCT for assistance. If equipment contamination is detected during the survey, the item will be decontaminated or bagged before removal from the Radiological Buffer Area. Such items may not be removed from the Radiological Buffer Area unless decontaminated.

9.8 EQUIPMENT DECONTAMINATION REQUIREMENTS AT WORK ZONE EXITS

When equipment and tools are used in a radiological area, contaminated items will be cleaned and decontaminated prior to being released from the work area. Typically, this will involve first removing any gross or visible contamination, followed by appropriate screening or sampling to evaluate if any radiological contamination remains. If contamination is detected, more thorough decontamination will be conducted until no detectable contamination remains, or the equipment otherwise meets the BJC's unrestricted release requirements.

Methods to minimize cleaning and decontamination activities will be identified and observed for activities in radiological area. Examples of these types of methods include:

- Using dedicated equipment whenever possible,
- Selecting and using equipment and tools that are easily cleaned and decontaminated (e.g., with minimum exposed porous surfaces such as engine filters on machines or wood handles on hand tools),
- Establishing control of work areas to minimize the movement of equipment and personnel.

Suitable equipment decontamination facilities will be arranged for performing these activities. When available, any existing BJC equipment decontamination facilities will be used. Otherwise, appropriate equipment decontamination facilities will be constructed as part **of** the negotiated scope of work for the WR.

9.9 PERSONAL PROTECTIVE CLOTHING SEGREGATION AND DISPOSAL REQUIREMENTS

When performing WR activities with potential contact with radioactive materials, after the removal of outer PPE, inner clothing will be inspected for dirt and debris. Any inner clothing with visible dirt and debris used in areas where the potential for radiological Contamination exists will be scanned for radioactivity. Any radioactive-contaminated clothing will remain on-site for washing by BJC. Laundered clothing will be returned for reuse when radiological surveying reveals that the contamination has been adequately removed. Any contaminated items that cannot be laundered, such as hard hats and chemical-resistant boots, must remain inside the contamination control zones, and remain there until they have been successfully decontaminated.

As directed by the RCT, SAIC team personnel will segregate and dispose of PPE in accordance with this ES&HP. The SAIC team will provide labeled radioactive material disposal bags for placement of soiled reusable cotton coveralls, company clothing, socks, towels, and disposable PPE. SAIC team personnel will write the work package number on the disposal bags using a permanent marker. Bagged reusable PPE will be sealed and placed in the BJC-furnished shipping containers. Used disposable PPE, respirator cartridges, and other disposable items will be containerized and taken to an identified location.

9.10 RADIOLOGICAL AREA EXIT REQUIREMENTS

Except as provided below, all SAIC team personnel exiting contamination control zones, as applicable, will survey themselves for contamination using the BJC-provided whole body or hand held contamination monitors. In the event that contamination is found on the worker's skin or clothing, the worker will notify BJC RCTs for decontamination before the individual is permitted to leave the area.

10. PERSONAL PROTECTIVE EQUIPMENT

Task-specific PPE requirements that meet applicable **OSHA** requirements shall be indicated in the **AHA,** which may be supplemented by a RWP. However, before requiring field team personnel to use PPE, appropriate administrative and engineering controls shall be implemented as the first means of defense for mitigating hazards and protecting site personnel.

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Personnel shall not be allowed to use PPE unless the hazards for which the PPE are intended to protect against have been assessed and the appropriate PPE has been specified in the AHA.

Personnel who use PPE to perform a job shall be trained to recognize the limitations of the equipment and to properly select, fit, use, inspect, maintain, and store the equipment. Such training shall occur and be documented before the user performs a task requiring the use of the PPE.

Whenever a significant change in site conditions or operations occurs, a qualified HS professional, the SSHR, or RCT, shall reassess the PPE requirements. The AHA/RWP shall be modified, as necessary, to indicate the revised PPE requirements.

It is the responsibility of each user of PPE to inspect the equipment before and as necessary during each use. Personnel wearing PPE shall be monitored periodically by a qualified person to ensure that they are adequately attired and protected.

10.1 RESPIRATORY PROTECTIVE EQUIPMENT

Overexposure to airborne contaminants is not anticipated on this project. Any use of respiratory protection must comply with requirements of 29 CFR 1910.134, SAIC's Corporate Respiratory Protection Program (SAIC ECHS **9),** the **RAAS** ES&H Plan, this document and the applicable AHA(s).

11. DECONTAMINATION

Procedures for personnel and equipment decontamination must be indicated in each ES&HP for HAZWOPER projects. Site-specific variances from general procedures shall be indicated in the ES&HP or other project-specific documents or records. The following general requirements apply to personnel and equipment decontamination processes for SPH work at HAZWOPER sites.

- Personnel, equipment, and vehicles must be decontaminated, as necessary, before exiting a contaminated area. Clothing and equipment that cannot be decontaminated sufficiently shall be properly contained and labeled prior to being transferred beyond the controlled work zones of the site. Such items should be handled and temporarily stored, pending analytical results, as though they are suspect contaminated waste. For sites having only radiological contamination, it is appropriate to first screen for radiological contamination to determine whether decontamination is necessary.

- If any significant contamination is encountered, PPE should be disposed rather than decontaminated for reuse.

- Loose contaminants (dusts and vapors) that cling to clothing or equipment shall be removed according to the applicable decontamination procedures (e.g., using a water or water-based detergent rinse and scrub brush), except when radiation action levels are exceeded.

- Care shall be taken to avoid generation of mixed (chemical and radiological) waste during decontamination operations.

- Rinse water and waste generated on-site shall be contained, temporarily stored, and disposed in compliance with applicable OSHA regulations (e.g., 1926.152).

505010

Where a centralized decontamination pad or facility will be established for decontaminating heavy equipment (e.g., rigs, augers, loaders), site-specific procedures for addressing transport of equipment from the work site to the centralized decontamination facility in a manner that minimizes the potential for, or contains the spread of, contamination are also to be indicated in the ES&HP.

Decontamination activities shall be monitored periodically by a qualified person to determine their effectiveness. If procedures are found to be ineffective, steps shall be taken to correct deficiencies, and any deviations from the ES&HP shall be documented.

11.1 SPECIAL PROCEDURES FOR DECONTAMINATION OF RADIOLOGICALLY CONTAMINATED PPE AND ENVIRONMENTAL MONITORING EQUIPMENT

When radiological contamination **is** detected above background levels, BJC shall be contacted before the contaminated item is removed from an area of contamination. Decontamination and disposal of PPE shall be conducted in accordance with the requirements of the **SAIC** BJC-approved RSP or the BJC Radiation Protection Program and the ES&HP.

12. EMERGENCY PLAN

In the event of **an** emergency, all site personnel shall follow the requirements and provisions of the PGDP Emergency Management Plan. Emergency response shall be provided by the PGDP emergency response organization. The SSHR will be in charge of personnel accountability during emergency activities. All personnel worlung on-site will be trained to recognize and report emergencies to the SSHR or their Supervisor. The SSHR or Supervisor will be responsible for notifying the PGDP emergency response organization.

The PGDP emergency response organization will be contacted for emergency response to all medical emergencies, fires, spills, or other emergencies. The plant shift superintendent **(PSS)** coordinates **24-h** emergency response coverage.

The emergency plan will be reviewed periodically. The requirements of this section will be communicated to site workers. Any new hazards or changes in the plan will also be communicated to site workers.

12.1 POTENTIAL EMERGENCIES

Potential emergencies which could be encountered during this project include, but are not limited to, fires, spills, and personnel exposure or injury.

12.2 FIRES

In the event of a fire, the PSS shall be notified immediately. If it is safe to do so, and they are properly trained, on-site personnel may attempt to extinguish an incipient fire with the available fire extinguisher and isolate any nearby flammable materials. If there is any doubt about the safety of extinguishing the fire, all personnel must evacuate to an assembly location and perform a headcount to ensure personnel are accounted for and are safely evacuated. The supervisor or knowledgeable employee will provide the fire department with relevant information.

505011

12.3 SPILLS

In the event of a spill or leak, the employee making the discovery will immediately vacate the area and notify other personnel and his/her supervisor. The supervisor will determine whether the leak is an incidental spill or whether an emergency response is required. If there is a probability that the spill will extend beyond the immediate area, result in an environmental insult, or exceed the capabilities of the on-site personnel, the supervisor is to inform the PSS, who will determine whether a response by the PGDP spill response team is warranted. If emergency response crews are mobilized, the supervisor or knowledgeable employee will provide the responders with relevant information.

12.4 MEDICAL EMERGENCIES

In the event of a medical emergency, the PSS is to be notified immediately. The **SAIC** team first-aid/CPR provider will serve as the designated first-aid provider. **Any** event that results in potential employee exposure to blood-borne pathogens will require a post-event evaluation and follow-up as required by 29 *CFR* 1910.1030. The supervisor will be notified as soon as practical after notifying the **PSS. A** person knowledgeable of the location and nature of the injury will meet the emergency response personnel to guide them to the injured person. Contaminated personnel will be decontaminated to the extent feasible. Personnel with minor injuries will follow full decontamination procedures. Personnel with serious injuries will be decontaminated by disrobing and wrapping in a blanket. Decontamination may be bypassed in the event of life-threatening injuries or illnesses.

12.5 EMERGENCY PHONE NUMBERS

Table C.6 list emergency groups and their telephone numbers. **A** cellular phone or radio will be present in the field and available for use when workers are not in close proximity to a plant phone. ***If an emergency occurs, contact the PSS first. The PSS is the trained site emergency response coordinator.***

Table C.6. Emergency group telephone numbers

	PGDP	Kevil
Plant shift superintendent		
Telephone:	6211	(270) 441-6211
If using cellular telephone:	(270) 441-6211	(270) 441-6211
Radio Number:	Alpha **1**	
Environmental Compliance:	6693	(270) 441-5051
Guard Shift Personnel:	6246	(270) 441-6246
Health Physics:	6411	(270) 441-5043
Industrial Hygiene:	6238	(270)441-5045/5040
Medical:	6266	(270) 441-6266
Safety:	6238	(270) 441-5227
Lourdes Hospital:		(270) 444-2444

PGDP = **Paducah** Gaseous **Diffusion Plant**

12.6 REPORTING AN EMERGENCY

Project personnel may be able to communicate by two-way hand-held radio (walkie-talkie), cellular telephone, or hard-wired phone on-site.

505012

12.6.1 Telephone

- If a plant telephone is accessible, dial **62**11. With a cellular phone, dial **(270)** 441-6211.
- Describe the type and the location of the emergency.
- Identify who is calling.
- Identify the number on the phone being used.
- *Tell whether an ambulance is needed.*
- Listen and follow any instructions that are given.
- Do not hang up until *after the* Emergency Control Center has hung up.

12.6.2 Fire Alarm Pull Boxes

Pulling a fire alarm box automatically transmits the location of the emergency to the Fire Department and the Emergency Control Center. The person pulling the alarm should remain at the alarm box, or nearest safe location, and supply any needed information to the emergency responders. Work personnel should note the location of pull boxes in each project area.

12.6.3 Radio

- By calling radio call number Alpha 1, the **PSS** is alerted of the emergency.
- Describe the type and the location **of** the emergency.
- Identify who is calling.
- Identify the number on the phone being used.
- *Tell whether an ambulance is needed.*
- Listen and follow any instructions that are given.
- **Do** not hang up until *after the* Emergency Control Center has hung up.

12.7 ALARM SIGNALS

12.7.1 Evacuation Alarms

Facility evacuation alarms are denoted by a steady or continuous sound from the site public address system. Proceed to the predetermined assembly. The assembly station director will provide further instruction.

12.7.2 Radiation Alarms

Radiation alarms are denoted by a steady sound from a clarion horn and rotating red beacon lights. Evacuate the site or area and proceed to the predetermined assembly station. The assembly station director will give further instruction.

12.7.3 Take-cover Alarms

Take-cover alarms are denoted by the intermittent or wailing siren sound from the site public address system. Employees should seek immediate protective cover in a strong sheltered part of a building and/or evacuate mobile structures to a permanent building.

12.7.4 Standard Alerting Tone

The standard alerting tone is a high/low tone from the public address system. Employees should listen carefully; an emergency announcement will follow.

12.8 EVACUATION PROCEDURES

The SSHR or Supervisor will designate the evacuation routes. Employees should familiarize themselves with the evacuation routes. In the event of an evacuation, they should proceed to the predetermined assembly station or designated area and wait for further instructions.

12.9 SHELTERING IN PLACE

Certain emergency conditions (i.e., chemical or radioactive material release, tornado warning, fire, security threat, etc.) may require that personnel be sheltered in place. The PGDP Emergency Director on the emergency public address system carries out notification of a recommendation of "sheltering. in place." "Sheltering in place" calls for employees to

- go indoors immediately (permanent building, not "mobile-type" structures)[C-400];
- close all windows and doors;
- turn off all sources of outdoor air (e.g., fans and air conditioners);
- shut down equipment and processes, as necessary, for safety; and
- remain indoors and listen for additional infomation on the public address system.

12.10 ON-SITE RELOCATION

Certain emergency conditions (i.e., chemical or radioactive material release, tornado warning, fire, security threat, etc.) may require that on-site personnel be relocated from their normal workstations and activities to locations more suitable to withstand the threat. The PGDP Emergency Director on the public address system carries out notification of on-site relocation. Specific instructions on where to relocate will be given with the message.

12.11 FACILITY EVACUATION

The PGDP Emergency Director initiates notification of facility evacuation over the public address system. Assembly stations serve as gathering points for evacuating personnel. These stations are identified with an orange, disk-shaped sign with the assembly station number in black lettering. In the event of an evacuation alarm, employees will evacuate to the designated assembly point for the area and immediately report to their supervisor or the assembly station director. The assembly station director will be wearing an orange vest. An accounting will be conducted of all personnel who have evacuated. The assembly station has a ring-down telephone to the PSS office and a local public address. Further instructions and information about the emergency situation will be given to employees by the assembly station director or over the site public address system.

12.12 EMERGENCY EQUIPMENT

Required items of emergency equipment will be maintained at the work location. These items will be specified by Industrial Hygiene, Radiation Control, Industrial Safety, the SSHR, and/or Fire Protection and may include, but are not limited to, the following:

- hard-wired or cellular telephone and radios,
- basic first-aid lut,

- fire extinguisher(s) or other fire extinguishing media, and
- a basic spill kit suitable to handle small spills.

13. TRAINING

The OSHA, DOE, and BJC HS training requirements applicable to SPH participants are presented in Appendix ***C*** and described in this section. In accordance with applicable OSHA training requirements, field team personnel shall have the necessary training to perform their assigned task(s) and associated responsibilities. The FS shall verify that each field team member has current certifications of required training before he/she, or his/her designee, tasks a field team member to perform a SPH Field duty.

13.1 GENERAL REQUIREMENTS

The training requirements of this section apply to all SPH Field operations.

13.1.1 HAZWOPER

Participants in this project will be required to have current HAZWOPER training as given in Attachment C Training Matrix. Visitors to the site must have permission of the **ESHR** and equivalent training to project personnel or be escorted by trained project personnel to enter the EZ.

13.1.2 RadWorker

Participants in this project will be required to have current RadWorker II training as required by the RWP and given in Attachment C Training Matrix. Visitors to the site must have permission of the ESHR and equivalent training to project personnel or be escorted by trained project personnel to enter the contamination area.

13.1.3 Pre-Job Start HS Briefing

The **SSHR,** or a qualified **HS** professional, shall conduct training on the content of the ES&HP before fieldwork begins so that each field team member is informed of the site-specific information and requirements applicable to the scope of work. This **HS** briefing shall cover the ES&HP contents and applicable portions of the RAAS ES&H Plan. Topics covered and attendance shall be documented.

13.1.4 Tailgate HS Meetings

Before beginning each day of Fieldwork, and as necessary during the day, the FS, SSHR, or a qualified HS professional, shall conduct a tailgate **HS** meeting to inform personnel of

- any newly identified hazards and associated monitoring and exposure control measures and results not discussed previously, and

- problems or concerns (especially HS) that have arisen since the previous tailgate meeting.

Field team members should be encouraged to discuss any HS-related concerns during this meeting without fear of reprisal. Topics covered and attendance shall be documented.

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13.1.5 First-Aid/CPR and Blood-Borne Pathogens

In accordance with 29 *CFR* 1926.50, in the absence of a hospital or clinic that is reasonably accessible in terms of time and distance **to** the work site, **a** person who has a valid certificate in first-aid/CPR training from the American Red Cross, or equivalent, shall be available at the work site to render first aid or CPR. The OSHA interpretation of 1910.1030 for employee protection from exposure to blood-borne pathogens is that requirement of 1910.1030 (e.g., training, a written blood-borne pathogen controls program, hepatitis-B vaccination, etc.) apply to any employee expected to render first aid or CPR on-the-job.

13.1.6 General Employee Training

Anyone who will perform SAIC SPH fieldwork and will be on-site (or a combination of sites) for more than 10 consecutive work days shall have current certification of having completed the BJC General Employee Training.

14. QUALITY CONTROL AND QUALITY ASSURANCE

14.1 SITE INSPECTIONS

SAIC shall conduct/document daily work area safety inspections and take corrective actions. These safety inspection documents shall be made available to the BJC STR upon request. The work supervisor shall inspect work activities against the hazardous work controls that are specified in applicable AHAs and permits.

The SSHR shall participate with the BJC STR and BJC safety advocate in weekly inspections of all SPH work areas under SAIC control.

15. RECORD KEEPING

15.1 SITE RECORDS

A record of daily HS-related events shall be documented and kept on-site (e.g., in a bound logbook and/or on suitable forms). The **FS,** or his/her delegate (e.g., an SSHR), shall verify employee training and medical surveillance records. Health physics personnel shall keep records of health physics-related events in accordance with requirements of their **RSP.** Records of all training must be maintained and available for oversight review.

15.2 EMPLOYEE EXPOSURE AND MEDICAL RECORDS

Employee exposure monitoring and medical records shall be retained by the employer of the employee in accordance with OSHA and DOE requirements (29 *CFR* 1910.1020 and 10 *CFR* 835.401 through 404 and 1101).

<u>Exposure records</u> for each employee monitored shall be maintained by the employer for 30 years. Specifically, records of radiological surveys, material and equipment release, exposure, dosimetry, dose

assessments, and instrument maintenance and calibration shall be documented and maintained by appropriate field team personnel.

Medical records shall not include examination or test results, but shall include the employee's name and social security number; the physician's written opinion and recommended limitations; any medical complaints related to exposure of hazardous substances; and a copy of the information provided to the examining physician by the employer (not including a copy of the OSHA standard).

Records shall be retained in accordance with, though not limited to, the following requirements.

- **To** the extent permitted by law, the employer shall maintain and keep records in confidence for each employee.

- Medical records for each employee shall be maintained by the employer for the duration of employment plus **30** years (except health insurance claims records maintained separately from the employer's medical surveillance program records, first-aid records of one-time treatments, and medical records of employees who have worked for the employer for less than one year and who have seen the records before termination).

- Records shall be maintained to document doses of radiation received by all individuals for whom monitoring is required per 10 *CFR* **835.402** and doses received during planned special exposures, accidents, and emergency conditions.

- At an employee's request, the employer shall provide the employee access to his/her records.

- At an employee's written request, the employer shall ensure that representatives designated by the employee have access to his/her record(s).

- Whenever an employee, or his/her designated representative, requests access to an employee record, the employer shall ensure that access is provided in a reasonable time and manner. If the employer cannot provide access to the record(s) within 15 worlung days, before the 15th worlung day following the request for access, the employer shall apprise the requester of the reason for the delay and the earliest date the record(s) can be made available.

- Whenever an employee, or his/her designated representative, requests a copy of a record, the employer shall ensure that

  — a copy of the record is provided without cost to such requester,

  — the necessary copying equipment is made available without cost to such requester for the purpose of copying the record, or

  — the record is lent to such requester for a reasonable time to enable a copy to be made.

- Once a record has been provided without cost to the requester, the employer may charge a reasonable, nondiscriminatory administrative cost for subsequent copies of the record. However, an employer shall not charge for an initial request for a copy of new information that has been added to a record, which was previously provided.

For purposes of follow-up investigation of an accident or incident, the employee's consent for the investigator(s) to access his/her records shall be obtained in accordance with 29 *CFR* 1910.1020.

15.3 EMPLOYEE NOTIFICATION OF PERSONAL EXPOSURE MONITORING RESULTS

In accordance with 29 *CFR* 1910.1020, notification of personal exposure monitoring (dosimetry) results must be provided to each employee (including another employers' employee) for whom exposure monitoring was performed. The notification form must be reviewed and acknowledged by each employee for whom monitoring has been conducted and notification provided. A copy of the notification form shall be provided to the subject employee and to his/her supervisor.

These records are confidential and shall be dealt with accordingly. The original form shall be retained with other original site records. Results of the exposure monitoring should be communicated to others in a manner that does not identify the employee for whom the monitoring was performed, including other affected on-site personnel during the tailgate HS meeting following receipt and evaluation of the results.

15.4 EMERGENCY/INCIDENT RECORDS

SAIC team employees are required to immediately notify their supervisor or the SSHR of any injury/illness, accident, incident, near-miss (potential bodily injury/illness or damage to equipment and facilities), potential Price Anderson Amendment Act noncompliance, environmental release, or any other unplanned event that may be a violation of a regulatory requirement or that may be viewed negatively by the public, the BJC, or DOE. The Project Manager then will notify the BJC STR immediately. If any of the aforementioned occur, the incident scene will not be changed without BJC concurrence unless it is to mitigate an immediate hazard or stop a spill in progress. SAIC team and BJC personnel shall jointly investigate each injuryhllness, accident, incident, near miss, or environmental noncompliance.

For accidents of any kind, a Supervisor Incident/Accident Investigation Report will be prepared and submitted to the BJC STR within 2 working days.

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ATTACHMENT A

ACTIVITY HAZARD ASSESSMENT

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ACTIVITY HAZARD ASSESSMENT

WORK LOCATION:

Building: Paducah Gaseous Diffusion Plant Outside C-400 Room: N/A

Column Number: N/A Other: N/A

SITE:

☐ K-25 ☐ X-10 ☐ Y-12 X Paducah

☐ Portsmouth ☐ Other: ____________

REVIEW SIGNATURES:

Prepare: ______________________ Date: / / Phone: ____________
(Required)

Safety and Health Manager/Designee: ______________________ Date: / / Phone: ____________
(Required)

Task Manager: ______________________ Date: / / Phone: ____________
(If Applicable)

Site Safety and Health Representative: ______________________ Date: / / Phone: ____________
(If Applicable)

Industrial Hygiene: ______________________ Date: / / Phone: ____________
(If Applicable)

Health Physics (SEC): ______________________ Date: / / Phone: ____________
(If Applicable)

APPROVAL SIGNATURE:

Project Manager: ______________________ Date: / / Phone: ____________

PLANT EMERGENCY TELEPHONE NUMBER: 911 ASSEMBLY POINT: #

This section to be completed by the Task Manager, signature in the space provided certifies that the following activities have been completed:

Task Manager's Craft Briefing: ______________________ Date: / /

AHA Posted at Job Site: ______________________ Date: / /

AHA TERMINATION:

Job site inspected and certified free of construction materials, equipment, signs and debris; AHA and permits recovered and returned to S&H; and all construction restrictions released.

Project Manager: ______________________ Date: / /

RETURN AHA TO S&H AT JOB COMPLETION. SUBCONTRACTOR IS TO RETURN AHA TO SAIC ES&H REPRESENTATIVE.

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ACTIVITY HAZARD ANALYSIS

[1] Project Number: 23900-BA-RM086F	**[2] AHA Number:** MAS-05-01, Rev. 0
[3] Subcontractor Name: SAIC	**[4] Lower-Tier Subcontractor(s):** PrSM Corporation, Geo Consultants, Others **TBD**
[5] Work Location: Southeast corner of the C-400 Building geographically located inside the Paducah Gaseous Diffusion Plant (PGDP) secure area.	**[6] Issue Date: 8/4/00**

Att A-4

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ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
of this project		• Employees shall be trained in the recognition of heat stress symptoms and appropriate precautions to take. • Personnel will be briefed on Attachment B of the ES&HP. • SSHR will monitor personnel for signs of heat stress. • Personnel will maintain fluid levels to avoid dehydration. • Personnel will utilize the "buddy system" to monitor coworker's condition.
	• **Hazardous Noise**	• Noise reduction requirements for hearing protection will be determined by the SSHR by conducting sound level readings if warranted. • Wear hearing protection if noise environments exceeding 85dBA.
		• SSHR will periodically monitor for explosive gases at the drill penetration point. HOLD **POINT:** If readings exceed 10% of the lower exposure limit (LEL), work will be immediately suspended and the situation will be further evaluated by the SSHR. The SA will be notified immediately of all suspension of work. Work will not proceed without approval from the SSHR.
Hoisting and Rigging activities	• Injuries due to inadequate planning	• Each individual lift or type of lit? must be evaluated prior to the lift to assess the potential hazards and identify the proper hoisting and rigging equipment needed to safely conduct the operation. Critical lifts will require a written lift plan. Planning will be conducted in accordance with Sect. 7 of the ES&HP.
	• Injuries due to defective equipment	• All hoisting and rigging equipment will be inspected prior to use.
	• Insufficient control of load	• Tag line(s) shall be required on all loads unless tag line creates a safety hazard (i.e., dragging on a high voltage line, critical valves, etc). Use as many tag lines as necessary to adequately control the load. • Personnel will maintain positive control of any load being hoisted or lifted throughout the movement of the load. Manual control and tag lines shall be utilized. Manual control may be used while the load is in contact with the ground. Tag lines will be used when the load is no longer in contact with the ground.
	• Injury due to being crushed by suspended load	• Personnel shall not stand or pass under a suspended load.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Any penetration or treatment of the ubsurface	• Exposure to radioactive contamination	• All personnel will be briefed on the applicable RWP prior to commencement of field activities addressed by the RWP. • Wear company clothing (scrubs), safety shoes, and impermeable gloves (i.e., latex or nitrile gloves), to protect against external contamination. Leather gloves may be worn over the impermeable gloves for protection from nonradiological hazards (i.e., sharp or rough edges). Safety glasses and a hard hat also will be worn while working within the designated work zones. Comply with the PPE requirements designated by the RWP and/or the BJC RCT. • Properly wear the issued TLD dosimeter. • SSHR will monitor the work site for possible radioactive contamination using BJC-provided survey equipment. • Perform all field work activities to maintain potential radiation exposures to ALARA. • All personnel must have current RadWorker II training. • Establish and maintain site control measures using designated work zones (i.e., exclusion, contamination reduction, and support zones). • **WORK HOLD POINT:** The **SSHR** will contact the SA and BJC RadCon immediately upon encountering any soils where the Beta/Gamma direct readings are **2X** (twice) the area background. **Work will be suspended** pending further guidance and/or field assessment as furnished or directed by BJC RadCon. • Baseline bioassay samples must be submitted prior to any SAIC team member engaging in work activities that may pose internal uptake of radioactive materials. Quarterly bioassay samples must be submitted in accordance with the RWP. • Work will be conducted in a manner to preclude/reduce the generation/spread of radiologically contaminated construction debris/spoilage, equipment, and PPE. Examples: Misting of dust generating activities, capture and containment of liquid waste, containerization of solid waste, seereeation of radioactive waste. minimization of all wastes.
	• Overexposure to airborne contaminants [trichloroethene (TCE) and other organic vapors]	• Process stack will be equipped with a continuous real time alarming PID monitor. • **SSHR** will monitor the worker's breathing zone for organic compounds using a PID when environmental sampling yields readings greater than 5ppm. HOLD POINT: If sustained readings greater than 5ppm are obtained, work will be suspended, personnel will withdraw, and the situation will be evaluated. The **FS** and H&S Manager will be notified along with the SA. • Two individuals representing the greatest exposure potential will be monitored using personal monitoring pumps and the appropriate sample media. **A** minimum of ten discreet full-work period samples for each of these individuals will be collected and analyzed. • Personnel will be notified of sample results. • **HOLD** POINT: If direct reading instruments indicate levels greater than 25ppm for over 15 min, then personal sampling will be initiated immediately on the worker with the highest expected exposure.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Any penetration or treatment of the subsurface (continued)	• Environmental air monitoring	• Real-time work area monitoring using a PID, and FID if necessary, will be conducted in the worker's breathing zone (2 to 3 ft from source or 14 inches in front of worker's shoulder). • Personal sampling of the worker breathing zone by lapel mounted sample tube will be conducted. • HOLD POINT: If organic vapor concentrations greater than 25 ppm are detected on a continuing basis, monitoring at the downwind perimeter of the work area will be initiated. • HOLD POINT: If organic vapor concentrations greater than 25 ppm are detected at the downwind perimeter, monitoring will be initiated at the upwind perimeter to determine if airborne concentrations are leaving the work area. • HOLD POINT: If visible dust is being generated, downwind perimeter observations must be initiated. If visible dust is seen migrating off-site, then dust-suppression methods shall be initiated (i.e., water misting).
Activities involving work with or near electrical tools or equipment	• Electrical shock from unsafe:	
	– Electric installations	• Electrical systems shall be installed by qualified electrician. • Electrical systems shall be inspected prior to use.
	– Portable electric tools	• Electrical tools shall be inspected prior to use. • Portable electric tools that are unsafe due to faulty plugs, damaged cords, or other reason shall be removed fiom service. • A Ground Fault Circuit Interrupter (GFCI) device shall protect portable electric tools and all cord and plug-connected equipment.
	– Extension cords	• Cords shall be inspected prior to, during, and after each use. • Extension cords that have faulty plugs, damaged insulation, or are unsafe in any way shall be removed fiom service. • Cords shall be protected from damage from sharp edges, projections, pinch points (doorways), and vehicular traffic. • Cords shall be suspended with a nonconductive support (rope, plastic ties, etc.).
	• Heavy equipment near power lines	• Operators shall maintain a minimum clearance with electrical power lines as dictated by the table in section 4.17.4
	• Drilling/driving rod into electrical lines	• An excavation/penetration permit IAW CP2-SH-IS 1045, Trenching, Excavation, and Penetration Permit, is required before driving grounding rods.
		• Equipment Penetrating more than two inches into concrete shall be grounded.
Biological hazards present in all phases of this project	• Injuries/illnesses due to biological hazards	• Brief personnel on hazards associated with insect bites (chiggers, ticks, spiders)/stings (wasps, bees, hornets) and poisonous plants (poison ivy, poison oak). • If warranted. use insect repellents according to manufacturer's directions.
(2) MOBILIZATION		
Material Handling—movement or transport of materials, supplies and equipment to the work site by manual and/or mechanical means	• Injuries resulting from manually lifting materials	• Employees should be instructed in safe lifting techniques: Back straight; bend at knees; load close to the body; lift smoothly; and do not twist. • Utilize material handling devices such as hand trucks. • Manual lifts of over 75 pounds require two people. Employees are encouraged to get help for any lift that appears excessive.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Material Handling (continued)	• Injury to head, feet, hands due to crushing, pinching, being caught between, striking against, and being struck by objects	• Wear at all times: hard hats, and sturdy, ankle high, safety-toed work boots. Leather gloves shall be worn when handling materials with rough, sharp, or slippery surfaces. Impermeable gloves (i.e., latex or nitrile) will be worn at all times within the work areas. Leather gloves will be worn over the impermeable gloves when needed.
	• Injury to eyes from airborne particulates, flying debris, and chemical exposure	• Protective eyewear with side shields that meet the ANSI 2-87.1 standard shall be worn at all times. If work conditions warrant, as determined by the **SSHR,** full face shields, goggles, or chemical goggles must be worn.
	• Slips, trips, and falls	• To the greatest extent possible, keep walking/working surfaces free of clutter, debris, and congestion. Brief personnel on hazards **of** wet, muddy soil hazards and traversing uneven grades.
	• Traffic	• Exercise caution and obey traffic regulations while transporting materials over roadways.
	• Stacking and storing **of** material	• All materials stored in tiers shall be stacked, racked, blocked, interlocked, or in some means secured to prevent sliding, falling, or collapsing. • Cylindrical materials such as piping shall be blocked, bound, or racked to contain spreading or rolling. • Used lumber shall have all nails removed. Lumber shall be stacked on level, supporting sills in such a way that it is stable and self-supporting.
	• Fire	• Storage areas and yards shall be kept free from accumulation of unnecessary combustible materials.
	• Flammable liquid storage	• Storage of gasoline and diesel fuels shall only be stored in approved containers. • No hot work, welding, or smoking shall be allowed within 50 ft of flammable and combustible liquid storage areas. • Flammable storage areas shall be provided with a minimum 20-lb ABC dry chemical fire extinguisher.
Use of Motor Vehicles	• Vehicles being in an unsafe mechanical condition	• SAIC vehicles shall be visually inspected before driving.
	• Vehicles not having required safety equipment	• All vehicles shall have properly functioning brake systems, brake lights, audible horn, powered wipers, defoggers/defrosters, and, if used in low visibility situations (dark, rain, fog), headlights and taillights (two each).
	• Damaged windshield **or** glass	• Cracked or broken windshields or glass shall be reported to the vehicle coordinator.
	• Improper Operation	• **All** vehicles and equipment shall be operated in accordance with the manufacturer's operating instructions.
Forklift Operations—Use of forklift(s) to transport materials, supplies, and equipment	• Untrained operators	• Only trained individuals shall be allowed to operate forklifts. Training shall be conducted as required by RAAS-030 and 29 *CFR* 1910.178 to ensure that the operator has the knowledge and skills needed to operate the powered industrial truck safely. • Personnel shall not be permitted to ride on powered industrial trucks.
	• Injuries due to unstable loads	• No employees shall pass under any elevated forks, whether loaded or not. • Loads shall be lowered, power shut off, and parking brake applied when fork trucks are left unattended. • Only stable or safely arranged loads that do not exceed the truck capacity, shall be handled. Caution shall be exercised when handling off-center loads that cannot be centered. • Only loads within the rated capacity of the truck shall be handled. • Forks will be of sufficient length to fully support the load. • Loads may be stabilized during transit by securing to the mast.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Forklift Operations (continued)	• Refueling of forklift	• Forklift will be shut down during refueling operations. • Forklift will be refueled using an OSHA compliant portable fuel container. • Personnel performing refueling operations will exercise caution to avoid spillage.
	• Collision with personnel	• The operator shall slow down and sound the horn in areas of limited visibility. • The fork truck shall be operated at a speed that allows it to be stopped in a safe manner.
	• Injuries to personnel during refueling forklift	• Refueling shall not be conducted on-site.
	• Injuries due to uncontrolled fork truck	• Stunt driving and horseplay shall not be permitted.
	• Injuries due to accidents related to forklift use on public roadways	• Forklifts operating on public roadways shall have an escort vehicle following behind the forklift. The escort vehicle will follow at a safe distance and have its emergency flashers on while performing escort duties. • Running over loose objects on the roadway surface shall be avoided.
	• Injuries due to failure of operator to perform preuse operational inspections	• Any power-operated industrial truck not in safe operating condition shall be removed from service. Authorized personnel shall make all repairs. • Industrial trucks shall be examined before being placed in service, and shall not be placed in service if the examination shows any condition adversely affecting the safety of the vehicle. Such examination shall be made at least daily. Defects, when found, shall be immediately reported and corrected.
Establishing fieldwork zones by placing signs, signals, and barricades	• Inadequate protection or warning provided to workers or other personnel	• Barricade area when it is necessary; construction site shall be identified with warning sign and flagging. Follow RWP requirements.
	• Safety signs not recognized	• There shall be no variation in the design of safety signs.
	• Vehicular traffic	• Street signs shall be used to advise motorists of construction activity or hazards on or adjacent to the roadway.
Minor assembly and adjustment of various items of equipment to be used during well construction and development		
• General Conditions as stated above	• See above	o See above.
• Use of Hand and Power Tools	• Contusions, abrasions, cuts, and amputations	o Tools shall be inspected prior to use. o All power tools originally equipped with a safety guard of any type shall be used only with the guard in place and functioning properly. o Defective tools shall be tagged and removed from service. o Tools shall be used only for their intended purpose. o Electric tools shall be unplugged when changing attachments or performing maintenance. o Pneumatic tools shall be disconnected and air pressures released before repair or adjustments are made. o Sections of air hoses that are not equipped with quick-release fittings shall be secured together with a safety chain or tie.

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ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Use of Hand and Power Tools (continued)	• Electric Shock	• Electric tools with missing ground prongs or cut or frayed cords shall be removed from service. • Electric tools used in highly conductive locations, such as where the employee may contact water, shall be approved for use in those locations. • Power for portable electric tools shall be supplied from a GFCI receptacle. • Electrical tools must be grounded, <u>except</u> tools that are equipped with double insulation. • Electric tools shall not be used in hazardous locations such as flammable or explosive atmospheres unless they are approved for such locations.
	• Bums	• Fuel powered tools (generators, pumps, etc.) shall be turned off during refueling. • Hydraulic powered tools shall use approved fire resistant fluids.
	• Tools and equipment being operated without guards	• Power operated tools and equipment designed to accommodate guards shall not be used without the guards in place and functioning properly. • All tools and equipment shall be used with the correct guard or attachment as specified by the manufacturer.
Jse of Machinery and Equipment	• Moving parts of equipment and machinery	• Moving parts of equipment (belts, gears, shafts, etc.) to which employees may be exposed shall be provided with guards.
	• Point of operation guarding	• The point of operation on equipment shall be guarded.
Delivery and installation of a field office trailer (NOTE: The trailer will be delivered, leveled, and anchored by the supplier.)	• Injury due to electrical shock while installing electric services to trailer	• Lockout/tagout permit, IAW CP2-SH-IS1065, will be needed if SAIC personnel perform installation of electrical service to the trailer. • If SAIC personnel perform the electrical system installation, he or she must have the appropriate electrical safetv training.
	• Contact with underground electrical service or other underground utilitv	• An excavation/penetration permit, IAW CP2-SH-IS1045, must be completed if in-ground anchors will be used to stabilize the trailer.
(3) WELL CONSTRUCTION & DEVELOPMENT		
Surveying	• See Work Activity 1 above, General Conditions. No unique hazards associated with this task	• See Work Activity 1 above, General Conditions.
General Construction	• Head injury	• Hard Hats shall be worn at all times.
	• Eye injury	• Protective eyewear with side shields that meet the ANSI Z-87.1 standard shall be worn at all times.
	• Hearing damage	• Hearing protection shall be worn when noise levels exceed 85dba.
	• Foot injury	• Sturdy, safety-toed boots shall be required.
	• Hand injury	• Leather gloves shall be worn when handling sharp, rough, or slippery materials.
	• Back Injury	• Employees shall be instructed on proper lifting techniques. (See above.)
	. .	elevated when crossing pathways.
	• Contamination being carried from the job site	• Personnel shall follow all check-out instructions on the Radiation Work Permit • All equipment will be checked by HP prior to egress from Radiation Work areas.
Personnel Monitoring	• Possible overexposure of personnel due to improper use of monitoring equipment	• SSHR must be fully trained on the calibration, use, and maintenance of all personnel monitoring equipment. • All monitoring equipment shall be calibrated prior to use.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Environmental Monitoring	• Possible contamination or spread of contamination to personnel, equipment, or environment due to improper use of monitoring equipment	• SSHR must be fully trained on the calibration, use, and maintenance of all environmental monitoring equipment. • All monitoring equipment shall be calibrated prior to use.
Decontamination of drilling rigs and associated equipment at the Decontamination Pad, C-752-C	• Skin/eye injury due to exposure to steam	• All decontamination personnel must be trained on the proper operation of the steam cleaner. • Personnel shall not hold equipment or parts being decontaminated. These items shall be positioned on a suitable surface and not held during decontamination. • Small parts will be contained in a perforated basket for decontamination. The steam jet will be off while personnel are rearranging small parts in the basket. • Personnel will wear a face shield over safety glasses and gauntlet length nitrile gloves while performing decontamination operations.
Steam Cleaner Operations—general	• Rotating equipment	• Steam cleaners will have protective guarding on all rotating shafts, belts, and pulleys.
	• Fire	• Turn off steam cleaner and allow cooling for before refueling.
	• Scald	• Steam cleaner hose connections will be inspected prior to use. • Steam cleaner wand will not be pointed at personnel
	• Hazardous Noise	• Noise reduction requirements for hearing protection will be determined by the SSHR by conducting sound level readings if warranted. • Wear hearing protection if noise environments exceeding 85dBA.
Drilling Operations	• Unauthorized Operation	• Only trained and authorized personnel will operate and/or assist in drilling operations.
	• Slips/trips/falls	• If mud pans are used, the pan will be cleaned out as often as possible to avoid slippery conditions.
	• Hoisting and Rigging Hazards	• See “Hoisting and Rigging Activities” under Item 1, General Conditions.
	• Rotating equipment	• Drill rigs will have protective guarding on all rotating shafts, belts, and pulleys. • Personnel will not wear loose fitting clothing or jewelry that may become entangled in machinery. • Personnel with long hair shall tie hair back to prevent entanglement in machinery.
	• Crushing injuries	• Drill rods and drill bit stabilizer will be transported properly either by a rack, the rig, or a utility trailer. • If transported on a trailer, the rods or stabilizers will be held securely in place. • Drill rig and wheeled equipment will have chocks placed under the wheels to prevent rolling.
	• Rig/equipment damage	• Rigs will be inspected daily and documented by the equipment operator. • Wire cables will be inspected daily, and cables with broken strands, weak spots, kinks, or mashed areas will be replaced prior to use. • FS/FOM and driller will inspect thread connections prior to start of fieldwork and weekly thereafter. • Prior to use, rigs will need to receive health physics approval. All rigs will be scanned with appropriate documentation. • The mast and cables must be able to support all equipment and drill rods. • Rigs must be maintained in good working order. • All rotating shafts, pulleys, or chains must be covered with protective guards. • All drill rigs must be equipped with an emergency kill switch, which is readily accessible to personnel at the rear of the rig. All personnel on the site will know the kill switch and how to use it.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Drilling Operations (continued)	• Refueling of drill rig	• Rig will be shut down during refueling operations. • Rig will be refueled using an OSHA compliant portable fuel container. • Personnel performing refueling operations will exercise caution to avoid spillage.
	• Water trucks/tanks	• All water tanks must be securely fastened to the vehicle frame. • Water tanks should be constructed of materials with adequate side strength, baffled to prevent the sloshing of water from side to side, and must have lids with gaskets to prevent water loss.
	• Fire	• Rigs, the grout plant, and the steam cleaner each will contain at least one ABC type fire extinguisher. • Fire extinguishers will be fully charged and inspected weekly. • Fuels will be stored in appropriate containers.
	• Severe Weather	• Drilling will stop when rain or other weather factor interferes with the safety of the operators. • Drilling activities will stop during lighting. Operators, crew, and other support personnel will move out of the exclusion zone and take shelter in the C-400 Chemical Operations office, or as directed by the Field Supervisor/Field Operations Manager.
	• Power lines/underground utilities	• If work is near an overhead line, care will be taken to ensure when raising the mast. • While working near power lines, drill rods will not be leaned against the mast. • If the drill bit encounters anything hard, drilling will stop, and the SSHR and Geologist will be notified. • All heavy equipment used in locations where the possibility exists to contact power lines, above or below ground, shall be grounded. An excavation/penetration permit IAW CP2-SH-IS1045, “Trenching, Excavation, and Penetration Permit,” is required before driving grounding rods.
	• Ionizing radiation	• Monitor for radiological contamination on equipment, to include the drilling rig, prior to removal from CRZ. • Personnel will self-monitor upon exiting CRZ. • Contact HP at 270-441-53 19 for further guidance if radiological contamination is identified. • Comply with all requirements of the RWP. • See Radiation Safety under Item 1, General Conditions.
	• Environmental protection	• At a minimum, plastic will be placed over the area to be drilled. If the contaminants warrant, plastic will be placed under the rig, as well as over a large area surrounding the rig. • If fuel or oil leaks on the plastic sheeting, absorbent pads will be used.
(4) DEMOBILIZATION		
General work activities are similar to Mobilization	• See Work Activity 2, Mobilization. Hazards presented during demobilization are the same as during mobilization.	• See Work Activity 2, Mobilization. Actions conducted during demobilization are the same as during mobilization.
Decontamination of Equipment at the Decontamination Pad, C-752-C	• Skin/eye injury due to exposure to steam	• All personnel must be trained on the proper operation of the steam cleaner. • Personnel shall not hold equipment or parts being decontaminated. These items shall be positioned on a suitable surface and not held during decontamination. • Small parts will be contained in a perforated basket for decontamination. The steam jet will be off while personnel are rearranging small parts in the basket. • Personnel will wear a face shield, nitrile gloves, and rubber apron while performing decontamination operations.

ACTIVITY HAZARD ANALYSIS (continued)

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Steam Cleaner Operations—general	• Rotating equipment	• Steam cleaners will have protective guarding on all rotating shafts, belts, and pulleys.
	• Fire	• Turn off steam cleaner and allow cooling before refueling.
	• Hazardous Noise	• Noise reduction requirements for hearing protection will be determined by the SSHR by conducting sound level readings if warranted. • Wear hearing protection if noise environments exceeding 85dBA.
	• Electric shock	• If a generator is powering steam cleaners, a Ground Fault Circuit Interrupter (GFCI) will be required.

ACTIVITY HAZARD ANALYSIS (continued)

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REVISION:		TRACKING #:		CONSTRUCTION PHASE:
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ATTACHMENT B

TEMPERATURE EXTREEMES

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HEAT STRESS

Applying the general risk factors below, tasks/projects can be anticipated for developing heat stress conditions.

- work performed in an outdoor or otherwise warm environment?
- work considered labor intensive?
- insulating or protective clothing worn?
- workers unacclimated?
- reflective surfaces or radiant heat sources present?
- workers in poor fitness or health?

Any single criterion above does not necessarily constitute a potential heat stress problem. The general rule to follow is that the more risk factors present—the higher the risk for personnel to develop a heat-induced illness.

When work is performed in a warm environment (risk factor 1), heat stress should be addressed in the AHA. When work is performed in a warm environment (risk factor 1) and one or more additional stresses are placed upon the body (risk factors 2-6), heat stress monitoring should be implemented to ensure that controls are adequate.

Heat stress monitoring consists of either environmental [wet-bulb globe temperature (WBGT)] or physiological monitoring (pulse, temperature, and weight). The health & safety professional has to exercise professional judgment in the implementation of heat stress monitoring. Heat stress monitoring does not have to be continuous; heat stress monitoring needs to be representative of the working conditions during the hottest part of the day/shift.

- Heart rate—Count the radial pulse as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If at the end of the following work period, the heart rate still exceeds 110, shorten the work period again by one-third.

- Oral Temperature—If the oral temperature exceeds 99.6°F (100.4°F core) taken with an Aural (ear) Thermometer, shorten the next work cycle by one-third, without a change in the rest period. If the oral temperature still exceeds 99.6°F at the end of the following work period, shorten the next work cycle by one-third. Do not permit a worker to perform duties requiring a semipermeable or impermeable garment if the oral temperature exceeds 100.6°F.

  Example of work/rest regimen in accordance to above protocol:
  Working time = 120 min (**2** h)
  Break time = 15 min

  If the work cycle is reduced by one third, the new work cycle is as follows:

  Working time = 120 min x .67 = 80 min
  Work time = 80 min (1 h & 20 min)
  Break time = 15 min

PHYSIOLOGICAL MONITORING

Perform physiological monitoring in accordance to Table 1. Employee temperatures and pulses should be taken at the beginning of the shift to establish their baseline (at rest) values. Take the temperature and pulse as early as possible in the rest period to ensure a more accurate reading. If the core body temperature exceeds 100.4°F, shorten the next work cycle by one-third and keep the rest period at the same length. If the core body temperature exceeds 100.4°F and the heart rate exceeds 110 beats per minute, the worker should sit down and take a break. If the temperature still exceeds the parameters at the end of the following work period, shorten the next work cycle by one third.

Table 1. Parameters for assessing and interpreting physiological data

Core temperature	Risk factor	Action
<99.6°F	Minimal	Periodic monitoring. Ensure that administrative controls are in place.
99.6°F–100.4°F	Moderate	Ensure that administrative controls are in place. Shorten next work cycle by one-third. If pulse exceeds 110, employee should take a work break; evaluate controls.
> 100.4°F	High	Do not permit worker to perform work duties; take a work break and examine worker for symptoms of heat illness. Controls are not adequate; evaluate and assess controls.

Example of work/rest regimen in accordance to above protocol:
Working time = 120 min (2 h)
Break time = 15 min

If the work cycle is reduced by one third, the new work cycle is as follows:

Working time = 120 min × **.67** = 80 min
Work time = **80** min (1 h & **20** min)
Break time = 15 min

Do not permit a worker to perform duties if the core body temperature exceeds 100.4°F. If a worker exceeds 100.4°F, the worker should be taken to a shaded area (preferably where air-conditioning or a fan is located) for a work break; please remove excess clothing, to the extent permissible, and supply him/her with cool drink. **If the worker is not exhibiting any heat strain symptoms,** he may resume work when his core temperature drops below 100.4°F and his resting pulse rate drops to **90** beats per minute. If an employee displays signs/symptoms of heat illness or is taking rest breaks with unusual frequency, then stop work and transport employee to the Occupational Medical Center for prompt evaluation.

ENVIRONMENTAL MONITORING

The WBGT index was developed as a basis for environmental heat stress monitoring. The WBGT combines the effect of humidity and air movement, radiant heat, and air temperature as factors in assessing heat stress. Examples of permissible heat exposure threshold limit values are shown in Table 2. TLV WBGT correction factors are shown in Table **3.**

Work Load Categories- The work load category may be established by ranking each job into light, medium, or heavy categories on the basis of type of operation:

- Light work—sitting or standing to control machines, performing light hands or **arm** work.
- Moderate work—walking about with moderate lifting and pushing.
- Heavy work—pick and shovel work.

Table 2. Examples of permissible heat exposure threshold limit values

Work–rest regimen	Work load		
	Light	**Moderate**	**Heavy**
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% Work— 25% Rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% Work— 50% Rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% Work— 75% Rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

Note: Values are given in °C (°F) wet-bulb globe temperature.

Table 3. TLV WBGT correction factors in °C for clothing

Clothing type	Clothing value	WBGT correction
Summer work uniform	0.6	0
Cotton coveralls	1.0	-2
Winter work uniform	1.4	-4
Water barrier, permeable	1.2	-6
Unacclimatized worker	NA	-2.5

NA = not applicable
TLV = threshold limit value
WBGT = wet-bulb globe temperature

STANDARD ADMINISTRATIVE CONTROLS

- Workers should drink plenty of fluids; It is recommend at least one cup every **20** min. Thirst is not an adequate indicator for fluid replacement. Workers should frequently drink small amounts of liquid refreshment.

- Use common sense, if workers feel overheated, they should take a break. Symptoms of heat-related disorders include: nausea, headache, pale complexion (skin is cool and clammy), feeling faint, and muscle cramps. Remember; provide frequent work breaks before workers experience the aforementioned symptoms. Work breaks may be adjusted so that fewer breaks are provided during the coolest hours of work, and more frequent breaks should be provided during the hottest hours of work.

- Acclimatize workers. Gradually increase the workload in a hot environment. ***An*** acclimatized worker will have a lower heart rate, **a** lower body temperature, a higher sweat rate and a more dilute sweat (less salt).

- Conduct as much work as possible during the late afternoon, nighttime, or early morning hours. Avoid performing hard physical labor during the middle of the day.

- Personnel that have a medical condition that may become exacerbated through heat stress conditions should consult with the Occupational Medical Department or their own physician prior to work.

- Job rotation of personnel is acceptable.

OTHER CONSIDERATIONS

- **PPE** such **as** ice vests or cool suits may be considered.

- In the absence of physiological monitoring, consider using ACGIH WBGT values as guidelines or recommendations to assist in the control of heat **stress.**

- Recommend **STA** training for workers that includes: the types of heat induced illnesses, heat strain symptoms, administrative controls in place, recommendations to prevent heat strain, and oversight monitoring being performed by safety personnel.

COLD STRESS

Persons working outdoors in low temperatures, especially at or below freezing, are subject to cold stress disorders. Exposure to extreme cold for even a short period of time can cause severe injury to the body surfaces and/or profound cooling, which can lead to death. Areas of the body that have high surface area-to-volume ratios, such as fingers, toes, and ears, are the most susceptible. Two basic types of cold disorders exist, localized (e.g., frostbite) and generalized (e.g., hypothermia). The descriptions, symptoms, and treatments for frostbite and hypothermia are provided below.

Frostbite: Frostbite is a condition in which the fluids around the cells of body tissues freeze, damaging the tissues. The most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes.

Symptoms: Affected areas become white and firm.

Treatment: Get the individual to a warm environment and re-warm the areas quickly. Keep affected areas covered and warm. Warm water can be used to thaw the areas

Hypothermia: As the temperature of the body drops, the thermoregulatory system attempts to increase the body's generation of heat, blood vessels are constricted to conserve energy, and glucose is produced to increase the body's metabolic rate (i.e., glucose is used as fuel to generate heat).

Symptoms: Uncontrollable shivering with the sensation of cold, slower heartbeat, and weaker pulse.

Treatment: Get individual to a warm environment.

Preventive Measures: A number of steps can be taken to minimize the potential for cold stress. Individuals can achieve a certain degree of acclimation when working in cold environments as they can for warm environments. The body will undergo some changes that increase the body's comfort and reduce the risk of cold injury.

- Working in a cold environment causes significant water losses through the skin and the lungs as a result of the dryness of the air. Increased fluid intake is essential to prevent dehydration, which affects the flow of blood to the extremities and increases the risk of cold injury. Warm, sweet, caffeine-free, nonalcoholic drinks as well as soups should be readily available.

- The skin should not be continuously exposed to sub-zero temperatures.

Cold Stress Monitoring: Air temperature alone is not a sufficient criterion on which to judge the potential for cold related disorders in a particular environment. Heat loss from convection (air movement at the surface of the skin) is probably the greatest and most deceptive factor in the loss of body heat. For this reason wind speeds as well as air temperatures need to be considered in the evaluation of the potential for cold stress disorders. The **ACGM** Threshold Limit Values and Biological Indices provide additional guidance on cold stress evaluation and the establishment of the work/rest regimen in environments conducive to cold stress.

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ATTACHMENT C

TRAINING

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Table 1. Training matrix

Training Type	Duration	Frequency	Provided By	Required For
Safety and Health Work Permits	2 h	As Required	BJC	All personnel, who issue, release, or request a Health and Safety Work Permit. S&HWP training <u>may not</u> be required for SUBCONTRACTOR personnel (excluding supervisor) if hazard control measures can be effectively demonstrated in AHAs or other Hazard Analysis documentation and the BJC grants approval.
PGDP General Topics GET	8 h	Initial'	BJC	All personnel working inside the security fence or any radiological controlled area
Security	2 h	Initial	BJC	All personnel working on DOE Property
Radiation Worker 1	6 h	Every 2 Years	BJC	All personnel working in fixed contamination, radiological areas, high radiological areas, radioactive material areas
Radiation Worker II	16h	Every 2 Years	BJC	All personnel working in fixed contamination, radiological areas, high radiological areas, radioactive material areas, contamination areas, high contamination areas, airborne radioactive areas
RCRA Permit Training	3 ½ h	Yearly	BJC	All personnel working in hazardous waste
Respirator Training	4 h	Initial'	SAIC team	Any personnel wearing respirators during the course of this contract
Respirator Fit-Testing	1 h	Yearly	SAIC team	Any personnel wearing respirators during the course of this contract
Hazard Communication	4 h	Initial	SAIC team	All personnel exposed to hazardous materials
Site training to include prejob safety meeting, AHA review, radiological work permit, daily safety meetings	Variable	Prior to performing hands-on work or entering restricted access areas and daily during the project	SAIC team	All on-site personnel
Forklift Operation	1 h training or verification of ability	Before forklift use	SAIC team	Forklift operator
Hearing Conservation	2 h	Initial	SAIC team	All personnel who may be exposed to noise levels at or above 85 dB 8-h TWA without regard to hearing protection devices
HAZWOPER Site Worker 40 h	40 h and 3-day OJT initial 8-h annual refresher	Initial	SAIC team	All personnel who will enter the exclusion zone.
HAZWOPER Supervisor	**8 h**	Prior to field activities	SAIC team	FM, FS, ESHR, Any supervisor directing work inside the EZ
HAZWOPER refresher	8 h	Prior to field activities	SAIC team	All personnel who will enter the exclusion zone who have had the 40 h initial training more than 12 months prior to field activities
Cardiopulmonary Resuscitation (CPR)	4 h	Yearly	SAIC team	SAIC team personnel designated to provide CPR and first-aid
First-Aid	8 h	Yearly	SAIC team	SAIC team personnel designated to provide CPR and first-aid
Blood-borne Pathogens	1 h	Initial	SAIC team	SAIC team personnel designated to provide CPR and first-aid

'GET continuing (1 h) may be substituted if personnel attended PGDP GET within the past 24 months.

[2] Additional fit-testing may be necessary if: determined necessary by the physician or other licensed health care professional; an employee is injured or becomes ill or develops signs or symptoms possibly due to an overexposure; an individual develops a condition that may affect his/her ability to wear a respirator, such as respiratory or cardiovascular diseases, diabetes, fear of tight or enclosed spaces, ruptured eardrum, defective vision, etc.; and, as soon as possible following an emergency incident.

AHA = activity hazard assessment
BJC = Bechtel Jacobs Company LLC
CPR = cardiopulmonary resuscitation
DOE = U.S. Department of Energy
ESHR = Environmental Safety and Health Representative
EZ = exclusion zone
FM = field manager
FS = field supervisor
GET = General Employee Training
HAZWOPER = Hazardous Waste Operations and Emergency Response
OJT = on-the-job training
PGDP = Paducah Gaseous Diffusion Plant
SAIC = Science Applications International Corporation
S&HWP = Safety and Health Work Permit

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ATTACHMENT D

HOSPITAL ROUTE MAP

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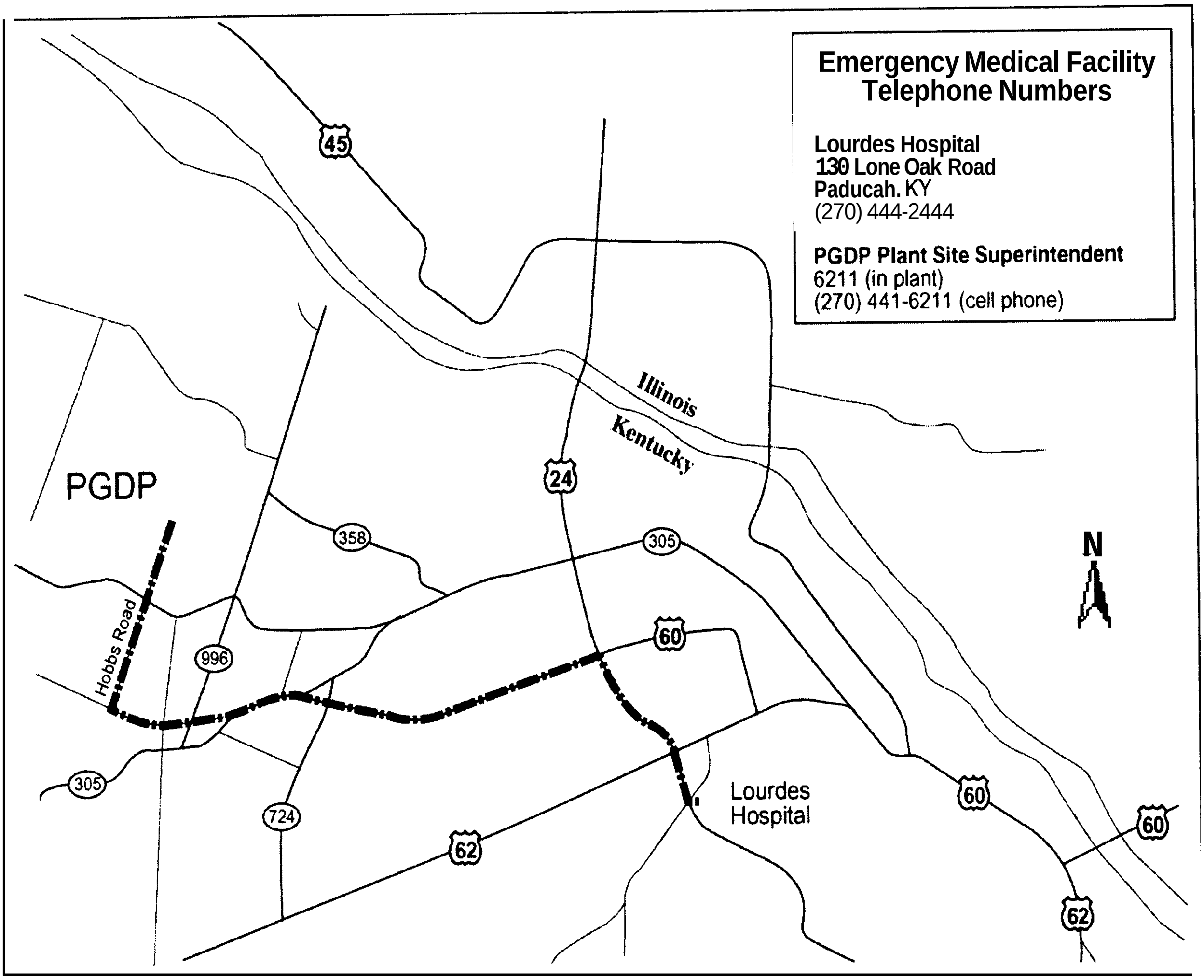

Attachment D. Hospital route map

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ATTACHMENT E

MATERIAL SAFETY DATA SHEETS

(To be **provided prior** to mobilization)

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ATTACHMENT F

HAZARDOUS MATERIAL INVENTORY

(To be provided prior to mobilization)

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ATTACHMENT G

G-3 CROSSWALK FOR THE SIX-PHASE HEATING TREATABILITY STUDY

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	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	Battery charging station	Activities where battery charging stations are owned, used, and/or maintained.	• 29 *CFR* 1910 • 29 *CFR* 1926 (see Footnote 1)	• Standard Fire Prevention Code (SFPC)	
☒	Electrical	Fire hazards associated with electrical equipment or work.	• 29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 70	• SFPC Chap. 7	ES&HP Sect 7.17
☒	Flammable materials and compressed gases	Applies to liquids, gases, solids use, and storage.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC Chap. 5, 10, 15, and 36	ES&HP Sect 7.16.2
☐	Mobile equipment	Activities in fire hazard areas.	• 29 *CFR* 1910	• SFPC	
☒	Open flame/burn	Open flames and burning in open areas (lab equipment, gas stoves, etc.).	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC Chap. 5	ES&HP Sect 7.3
☐	Radiant heat, closed systems	Activities that use radiant heaters (includes office heaters) and steam heating systems.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC	
☐	Radiant heat, open flame	Activities that use portable oil and gas heaters.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC	
☐	Spark-producing tools near flammables	Activities in a flammable or explosive atmosphere.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC Chap. 25	
☐	Spontaneous combustion	Activities where oily rags, cleaning rags, etc., are stored.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC Chap. 5 and 10	
☒	Combustion engines	Applies to portable engines (such as power generators) and stationary engines.	• 29 *CFR* 1910 • 29 *CFR* 1926	• SFPC Chap. 5,504.1.5 • NFPA 37	AHA
☒	Storage of combustibles	Identify items like pallets, boxes of material, lubricating oils, etc.	• 29 *CFR* 1910	• SFPC Chap. 5,502.3	ES&HP Sect. 7.16.2
☐	Transportation (vehicle fueling)	Activities that involve "on-site" refueling of equipment.	• IA–Work planning will specify the appropriate controls.	• SFPC Chap. 9, Sec. 907 • NFPA 30A for service stations • NFPA 30 for fuel transfers	ES&HP Sect 7.16.3

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☒	Welding, torch, cutting, and brazing		• 29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 51B	• SFPC Chap. 29	ES&HP Sect 7.3
☒	Fire prevention		• 29 *CFR* 1910 • 29 *CFR* 1926 • 40 *CFR* 264 • IA–Fire prevention or response elements may be modified, reduced, or eliminated when justified by an evaluation that demonstrates an equivalent level of protection or an acceptably low risk to personnel and the environment. Such modification, reduction, or elimination of protection shall be approved by the DOE-OR0 AHJ for fire protection matters.	• Kentucky Building Code	ES&HP Sect 7.16
☒	Fire rescue/response		• 29 *CFR* 1910 • TCA-68-140 • ORC 47:473 1 • for IAs, see Footnotes 1 and 2	• ANSI/ANS-8.22	ES&HP Sect 12.2
☐	Batteries	Activities where batteries are used or maintained (e.g., to provide backup power for building systems).	• 29 *CFR* 1910 • 29 *CFR* 1926		
☒	Exposed to <600 V		• 29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 70 • ANSI C2 • NFPA 70E		ES&HP Sect 7.17.2
☐	**Exposed to >600 V**				
☐	Exposed to >600 V	Activities involving work on the power distribution system (either aerial or	• 29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 70 • ANSI C2 • NFPA 70E	• ASTM F1236-89	
☐	Temporary lighting		• 29 *CFR* 1910 • 29 *CFR* 1926		
☐	Stored energy/capacitors or inductors		• 29 *CFR* 1910 • 29 *CFR* 1926		

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	Substations/transformers		• 29 ***CFR*** 1910 • NFPA 70E		
☐	Electrical magnetic fields	Activities at or near electrically-generated magnetic fields (includes fringe fields and quench effects).	• ACGIH, most current (IA—Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☐	Static electricity	Activities which involve the transfer/ handling of flammable/ignitable liquids (especially petroleum products such **as** gasoline, kerosene, etc.)	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
NON					
☐	Laser	Laser wands used for presentations are **not** identified.	• 29 ***CFR*** 1926 • ANSI Z 136.1 (1993) • ACGIH, most current (IA—Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☐	Radio frequency and microwave radiation	Activities where RF and MW (315 Hz - 300 KHz) are encountered (does not include MW cooking).	• 29 ***CFR*** 1910 • ANSI Z 49.1 • ACGIH, most current (IA–Professional judgment of IH will be used **to** select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).	• 29 ***CFR*** 1910.97	
☒	Ultraviolet radiation	Activities where work will be conducted out-of-doors or near ultraviolet sources.	• ANSI Z 49.1 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP AHA

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	**Intense light source**	Activities at or near intense light (e.g., welding, torch cutting, hot or molten materials).	• ACGIH, most current (IA—Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
ION[ZING RADIATION					
☒	Radiation Exposure	Activities that involve radioactive materials or radiation generators that may result in internal and/or external radiation exposures (sources, medical x-ray equipment).	• 10 ***CFR*** 835 • DOE N 441.1, sec. 6.d, 6.f • DOE N 441.1, sec. 6.e (IA–Maintenance of the applicable NRC license for sealed sources will be acceptable).	• DOE N 441.1, sec 6.c	ES&HP Sect 9, AHA and RWP
☒	Radioactive contamination	Activities that could cause air-borne contamination and/or re-movable surface contamination that could result in internal uptake and/or contamination spread.	• 10 ***CFR*** 835 • DOE N 441.1, sec. 6.d, 6.f • DOE N 441.1, sec. 6.e (IA–Maintenance of the applicable NRC license for sealed sources will be acceptable).	• **DOE N 441.1, sec 6.c**	ES&HP Sect 9, AHA and RWP
☐	Fissile material	Activities that involve fissile material(s) inspection, storage, configuration change, use, or transportation.	• 10 ***CFR*** 830.120 • 10 ***CFR*** 835 (nuclear accident dosimetry) • ANSVANS-8.1 (for IA and IGs, see Footnote 3) • ANSI/ANS-8.3 (for IAs, see Footnote 4) • ANSI/ANS-8.7 (for IAs, see Footnote 5) • ANSI/ANS-8.15 • ANSVANS-8.17 • ANSI/ANS-8.19 (for IG, see Footnote 6) • ANSI/ANS-8.20 (for IA, see Footnote 2	• ANSI/ANS-8.5 • ANSI/ANS-8.10 • ANSI/ANS-8.21 • ANSWANS-8.22 • ANSI/ANS-10.4 • DOE-STD-3007	
MATERIAL HANDLING					
☐	Compressed gas cylinders	Activities involving the handling and storage of cylinders (inert, flammable, toxic).	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.4
☐	Conveyer systems		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☒	Cranes and hoists; hoisting, rigging, and material handling	Activities where the use of gantry, overhead, mono-rail, and portable cranes will be used. Does not include personnel work platforms.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926 • ANSI B30.2 • ANSI B30.5 • ANSI B30.10 • ANSI B30.11 • ANSI B30.16 • ANSI B30.20 • ANSI B30.21 • ANSI B56.6	• Technical Standard 1090–Hoisting and Rigging, Ch. 2 (for critical lifts only) and Addendum 1 (procurement guidelines).	ES&HP Sect 7.12
☐	Elevators		• ANSI/ASME A 17.1 • ANSI/ASME A 17.2.1 • ANSI/ASME A 17.2.2 • ANSI/ASME A 17.3 • ASME A 17.5		
☒	Fork lift operation		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.15.3 and AHA
☐	Hazardous equipment and machinery	e.g., banding machines.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Storage/handling of toxic materials		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Transportation of DOT hazardous materials on-site	Includes radioactive material.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Transportation of DOT hazardous materials off-site	Includes radioactive material.	• 49 ***CFR*** 106 - 199 • 49 ***CFR*** 325 - 399		
☐	Transportation of hazardous waste on-site	Includes radioactive material.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Transportation of non-hazardous material off-site		• 49 ***CFR*** 325 - 399		
☒			• 29 ***CFR*** 1926		
☐	Microbes (water)	Activities conducted on stagnant ponds, pools of water, cooling towers, etc.	• IA–Work planning will specify the appropriate controls.		
☐	Indoor air	Bacteria, fumes, etc.	• ANSYASHRAE 62-1989	• Building Air Quality–EPA manual	
☐	Mold and mildew, bird droppings		* 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Poisonous plants	Such as poison ivy, etc.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	used by SUBCONTRACTOR
☒	Blood-borne pathogens	Activities where employees may be occupationally exposed to blood or potentially infectious materials.	-29 ***CFR*** 1910	• 29 ***CFR*** 1910.1030	ES&HP Sect 13.1.3
THERMAL					
☐	Cryogens	Activities where cooling materials such as liauid nitrogen are used or stored.	-29 ***CFR*** 1910		
☒	Hot/cold work environment		-29 ***CFR*** 1910 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).	• Occupational Health and Safety Guidance Manual for Hazardous Waste Site Activities for nonpermeable PPE (NIOSH).	SSHP Sect 7.8 and Attachment B
☐	High temperature equipment/materials	Activities where equipment/ materials that generates intense heat is used.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Asbestos/man-made mineral fibers		-29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Asphyxiating gases	Activities that could release sufficient gases which (1) displace oxygen and result in an oxygen-deficient atmosphere (e.g., nitrogen, hydrogen, Freon, argon, or carbon dioxide) or (2) interfere with bodily use of oxygen (e.g., carbon monoxide).	-29 ***CFR*** 1910 • 29 ***CFR*** 1926 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☐	Confined spaces	Activities conducted within "con-fined spaces" as identified by OSHA.	-29 ***CFR*** 1910 • 29 ***CFR*** 1926		
☐	Dry environment	Activities conducted in a hot, dry environment such as furnace ovens, etc.	• ANSI/ASHRAE 62-1989		
☐	Elevated work	Activities with potential for falls from elevated surfaces. Heights and configurations specified in OSHA.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.10
☐	Eyedamage	Debris-generating activities (e.g., grinding, cutting, cleaning with compressed air).	-29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.5

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	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☒	Hazardous materials/waste		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926 • ANSI Z 358.1 • ANSI/ASHRAE 62-1989 • ACGIH, most current (IA - Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP Sect 6.5 and Sect 8.1
☒	High noise levels		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926 • ACGIH, most current (IA–Professionaljudgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP Sect 7.5 and Sect 8.1
☒	Lifting/carrying heavy objects	Activities where personnel move the heavy objects.	• 29 ***CFR*** 1926		ES&HP sect 7.5
☒	Pinch points		• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.13
☐	Repetitive motion	Ergonomics, cumulative trauma disorders.	• IA–Work planning will specify the appropriate controls.		
☒	Sharp edges	Sheet metal work, equipment loading, etc.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926		ES&HP Sect 7.13
☒	Traffic	Activities involving on-site roadway transportation or activities near traffic areas (i.e., cars, carts, fork lifts, bicycles).	• IA–Work planning will specify the appropriate controls.	• ATSSA Manual on Uniform Traffic Control Devices.	ES&HP Sect 7.15
☐	Vibrating equipment	Activities where handheld saws, decontamination scabbling, or hammering equipment is used.	• 29 ***CFR*** 1910 • 29 ***CFR*** 1926 • ACGIH, most current (IA–Professionaljudgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		

Att G-9

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☒	Walking/working surfaces	Identify: 1. General surface hazards such as irregular surfaces, floor grating, wet surfaces, scaffolds, or ladders. 2. Low overheads and protrusions into walking and work areas (e.g., pipes, wiring, or air conditioners).	• 29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 7.11
☒	Excavation/penetration		• 29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 7.14
☐	Demolition	Activities where machinery is used to demolish.	• 29 *CFR* 1910 • 29 *CFR* 1926		
☐	Food preparation		• 29 *CFR* 1910		
☒	Acids, solvents, toxic agents, and hazardous liquids	Includes sensitizers.	• 29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 45 (IA - for laboratories only) • ANSI Z 358.1 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).	• U.S. Coast Guard CHRIS Compatibility Chart	ES&HP Sect 8
☐	Beryllium		• 29 *CFR* 1910 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☒	Carcinogens		• 29 *CFR* 1910 • 29 *CFR* 1926 • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP Sect 8 and AHA RWP
☐	Explosive and blasting agents	Storage and use for activities such as demolition.	• 29 *CFR* 1910 • 29 *CFR* 1926 • 805 *KAR* 4		

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	Heavy metals	Lead, mercury, etc.	• **29 *CFR* 1910** • **29 *CFR* 1926** • ACGIH, most current (IA — Professionaljudgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☒	Nuisance dusts	Activities that may generate or be exposed to dusts.	• **29 *CFR* 1910** • **29 *CFR* 1926** • ACGIH, most current (IA–Professionaljudgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP Sect 8 and AHA
☐	Pesticides, herbicides (FIFRA)		• **40 *CFR* Part 170**		
☐	Pesticides, herbicides (non-FIFRA)		• **29 *CFR* 1910** • **29 *CFR* 1926** • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☐	Toxicity in smoke or fumes	Activities which may generate smoke, fumes, etc., not associated with welding, cutting, or hot work (e.g., open burning of brush, exhaust emissions, HF releases).	• **29 *CFR* 1910** • **29 *CFR* 1926** • ANSVASHRAE **62-1989** • ACGIH, most current (IA–Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		
☒	Welding, cutting, hot work fumes		• **29 *CFR* 1910** • **29 *CFR* 1926** • ANSVASHRAE **62-1989** • ANSI **Z 49.1** • ACGIH, most current		ES&HP Sect 7.3

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	Reproductive	Activities that involve occupational exposure to chemical, physical, or biological agents of concern.	• 29 *CFR* 1910 • 29 *CFR* 1926 • ANSI/ASHRAE 62-1989 • ACGIH, most current (IA—Professional judgment of IH will be used to select the appropriate exposure standard (e.g., TLVs, AIHA WEELs, and NIOSH RELs).		ES&HP Sect. 9 RWP
MI	**CHANICAL**				
☐	Pressure systems	Used to identify systems and equipment containing stored pressure energy (e.g., air, steam, water, hydraulic)	• 29 *CFR* 1910 • 29 *CFR* 1926 • ASME B&PV Code • ANSI/ASME B31		ES&HP Sect 9.4 and AHA
☒	Machinery and rotating parts	Aspects of pinch, crush, or hydraulic spray from the in-place operation of equipment (e.g., the working components of a brake, shear, lathe, drill press, drilling rigs, backhoes. bulldozers. or jacks).	• 29 *CFR* 1910 • 29 *CFR* 1926		ES&HP AHA
☐	Material grinding, cutting, drilling		• 29 *CFR* 1910 • 29 *CFR* 1926	• IADC Accident Prevention Manual for Drilling	
☒	Mobile equipment	Aspects of pinch, crush, or run over personnel from movement of the entire piece of equipment (e.g., drilling rigs, backhoes. or bulldozers).	• 29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 7.15
☐	Moving equipment	Aspects of pinch or crush personnel from movement of the major equipment components (e.g., bridge cranes or monorails).	• 29 *CFR* 1910 • 29 *CFR* 1926		
☐	Moving vehicles, carts, and bicycles	Activities where employees use vehicles, carts, bicycles <u>inside</u> facilities.	• 29 *CFR* 1910 • 29 *CFR* 1926 • TCA 55-8-101		
☐	Powered platforms		• 29 *CFR* 1910 • 29 *CFR* 1926		
☐	Railroad systems	Inspection and maintenance of railroad systems in Tennessee (excludes rail operations beyond the use of service vehicles for maintenance).	• 49 *CFR* 213 • 49 *CFR* 214 • 49 *CFR* 216 • 49 *CFR* 234 **(IA–49 *CFR*** 234 applies only to track on DOE property) • 49 *CFR* 236		

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☐	Special hand tools	Air wrenches, special saws, powder-actuated nail guns, etc.	-29 *CFR* 1910 • 29 *CFR* 1926		
☐	Stored mechanical energy	Used to identify equipment under tension or temporarily elevated (e.g., compressed spring, blocked door).	• 29 *CFR* 1910 • 29 *CFR* 1926		
OTHER					
☐	Boating and watercraft		• 29 *CFR* 1910 • 29 *CFR* 1926 • Kentucky–Title XIX–Chap. 235		
☐	Drowning	Activities over or near water.	• 29 *CFR* 1910 • 29 *CFR* 1926		
☐	Aviation	Aircraft flights 1) without passengers (e.g., aerial surveys) or 2) with passengers (e.g., charter flights).	• 14 *CFR* 77 • 14 *CFR* 91 • 14 *CFR* 135 • 49 *CFR* 830	• DOE Order 440.2	
☐	Firearms	Firearms use and storage of ammunition (security personnel). Activities which would involve exposure to hunting in Paducah Wildlife Management Area.	• DOE O 440.1, **Att.2,** BJC Requirements Document, para.	• DOE-STD-1091-96, Firearms Safety	
☐	General office	Facilities, office equipment, work-place stress, etc.	• 29 *CFR* 1910	• ANSI/IES RP-1 • ANSI/ASHRAE 62-1989	
☒	Housekeeping		-29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 7.9
☒	Egress		-29 *CFR* 1910 • 29 *CFR* 1926 • NFPA 101 • NFPA 101A		ES&HP Sect 9, Sect 12 and AHA
☐	Illumination		• 29 *CFR* 1910 • 29 *CFR* 1926	• ANSI/IES RP-1 • ANSI/IES RP-7	
☒	Sanitation		• 29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 7.9
☒	Weather-related exposure	Activities where employees could be exposed **to** high winds, lightning, hail, rain, snow, etc.	-29 *CFR* 1910 • 29 *CFR* 1926		ES&HP Sect 12
☐	Imminent dangers		• PL. 91-596, section 5(a)(1)		ES&HP Sect 7.6, Sect 12 and **AHA**

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Implementation Guide	Work Control Documents to be used by SUBCONTRACTOR
☒	Injury and illness reporting		• 29 *CFR* 1904	• DOE O 231.1, *Injury and Illness Reporting*	ES&HP Sect 15.4

acceptably low risk to personnel and the environment. Such modification, reduction, or elimination of protection shall be approved by the DOE-ORO authority having jurisdiction (AHJ) for fire protection matters.

[2] IA–The fire protection program shall establish guidelines for fire fighting within, or adjacent to, fissile material areas that use moderator control. These guidelines shall be based on comparisons of the risks and consequences of a criticality accident with the risks and consequences of postulated fires for the respective area(s). Risk and consequence comparisons may be a qualitative evaluation. The basis for the guidelines shall be documented and shall be consistent with the authorization basis documentation.

[3] ANSI/ANS-8.1: (IA–Sect. 3.3, Glossary of Terms, shall be read as follows: Bias—A measure of the systematic disagreement between the results calculated by a method and experimental data. The uncertainty in the bias provides a measure of the accuracy and the precision of the calculated values and also the experimental data. In determining and using bias, NCS analysts must recognize that accuracy may not be known or well understood in the calculated values and the experimental data and that precision may not be well characterized in the experimental data.)

(IA–Sect. 4.2.2, Double Contingency Principle, shall be read as follows: Protection shall be provided by either (i) the control of two independent process parameters [which is the preferred approach, when practical, to prevent common-mode failure] or (ii) a system of multiple controls on a single-process parameter. The number of controls required upon a single-controlled process parameter shall be based upon control reliability and any features that mitigate the consequences of control failure. An exception to the application of double contingency, where single contingency operations are preferable, is presented in paragraph **5.1** of ANSI/ANS-8.10. This exception applies to operations with shielding and confinement (e.g., hot cells or other shielded facilities). Process designs that do not incorporate the above factors of safety shall be justified and documented and the analysis must be approved by DOE.)

(IG–Sect. 4.2.3, Geometry Control, first sentence, may be satisfied in the following manner: Where a significant quantity of fissionable material is being processed and criticality safety is a concern, passive-engineered controls such as geometry control shall be considered as a preferred control method. Where passive-engineered control is not feasible, the preferred order of controls is active engineered controls followed by administrative controls. The analysis shall support the chosen controls.)

(IA–Sect. 4.2.3, Geometry Control, third sentence, shall be interpreted as: All dimensions, nuclear properties, and other features upon which reliance is placed shall be documented and verified prior to beginning operations and control shall be exercised to maintain them.)

[4] ANSI/ANS-8.3:
(IA–Requirements relating to the needs for an alarm system (paragraphs 4.1.1 4.2.1 and 4.2.2) may be satisfied in the following manner; otherwise, compliance with ANSI/ANS 8.3 is required. Criticality Accident Alarm Systems (CAAS) and Criticality Detection Systems (CDS) shall be required as follows (citation of the 10-6/year frequency in what follows does not mean that a probabilistic risk analysis must be performed, engineering judgment may be instead substituted):

(1) In those facilities where the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3 and the probability of a criticality accident is greater than 10-6 per year (as documented in a DOE-approved Safety Analysis Report (SAR) or in the supporting analysis for an SAR), a CAAS conforming to ANSI/ANS-8.3 shall be provided to cover occupied areas in which the expected dose exceeds 12 rads in free air, where a CAAS is defined to include a criticality accident detection device and a personnel evacuation alarm. *An* unoccupied area is one for which the combination of physical barriers and administrative controls prevents lawful entry.

(2) In those facilities where the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3 and the probability of a criticality accident is greater than 10-6 per year (as documented in a DOE-approved Safety Analysis Report [SAR] or in the supporting analysis for an SAR) but there are no occupied areas in which the expected dose exceeds 12 rads in free air, a CDS shall be provided, where a CDS is defined to be an appropriate criticality accident detection device but without an

immediate evacuation alarm. The CDS response time should be sufficient to allow for appropriate process-related mitigation and recovery actions. Appropriate response guidance to minimize personnel exposure shall be provided by the BJC.

(3) In those facilities where the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3 but a criticality accident is determined to be impossible due to the physical form of the fissionable material, or the probability of occurrence is determined to be less than 10-6 per year (as documented in a DOE-approved Safety Analysis Report (SAR) or in the supporting analysis for an *SAR* or in other appropriate documentation), neither a CAAS nor a CDS is required.

Neither a CAAS nor a CDS is required for fissionable material during shipment when packaged in approved shipping containers or when packaged in approved shipping containers awaiting transport provided that no other operation involving fissionable material not so packaged is permitted on the shipping dock or in the shipment area.

(4) If a criticality accident is possible wherein a slow (i.e., quasistatic) increase in reactivity could occur leading from subcriticality to supercriticality to self-shutdown without setting off emplaced criticality alarms, then a CAS might not be adequate for protection against the consequences of such an accident.

To aid in protecting workers against the consequences of slow criticality accidents in facilities where analysis has shown that slow criticality accidents are credible, CASs should be supplemented by warning devices such as audible personnel dosimeters (e.g., pocket chirpers/flashers or their equivalents), area radiation monitors, area dosimeters, or integrating CAASs. If these devices are used solely as criticality warning devices, they shall meet the requirements for monitoring instruments of 10 CFR 835.401.

(5) Neither a CAAS nor a CDS is required to be installed for handling or storage of fissionable material when sufficient shielding exists that is adequate to protect personnel (e.g., spent fuel pools, hot cells, or burial grounds); however, a means to detect fission product gasses or other volatile fission products should be provided in occupied areas immediately adjacent to such shielded areas, except for systems where no fission products are likely to be released.

(IA–Sect. 5.3 may be satisfied in the following manner: The detection unit and primary annunciator of new criticality alarm systems or major modifications to existing systems shall remain operable in the event of seismic shock equivalent to the seismic qualification of the building, if such exists, or in the absence of same the lesser of a) the site-specific design basis earthquake, b) the value specified in the Uniform Building Code, or c) the threshold acceleration value to which the building was designed.)

[5] ANSI/ANS-8.7 (IA–In Sect. 5.2, the third sentence shall be interpreted as: The effects of more significant moderation shall be evaluated using a validated computational technique.)

[6] IA–The BJC shall have processes to identify and evaluate inadvertent accumulation of significant quantities of fissionable material. Processes include protocols, methods, approaches, or other systematic means to ensure that inadvertent accumulations either do not occur or are recognized and controlled.

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☐	Air emissions		• 401 *KAR* 50, 51, 53, 57, 59, 61, and 63	
☐	Construction of a new air emission source or modification of an existing one		• 40 CFR 60 • 401 KAR 50, 51, 53, 57, 59, 60, 61, and 63	
☐	Emissions of a hazardous air pollutant	Hazardous air pollutants for NESHAPs are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride.	• 40 CFR 61 • 401 KAR 50 and 57	
☐	Emissions from an industrial source category	Source categories are listed in 57 FR 31576 (July 16, 1992).	• 40 CFR 63 • 401 KAR 50.61. and 63	
☐	Storage or use in one process unit of a regulated substance in excess of its threshold quantity	Regulated substances and their threshold quantities are listed in 40 CFR 68.130.	• 40 CFR 68 • 106 KAR 1	
☐	A significant increase in emissions from modification of an existing source or construction of a new source	"Significant" increase is defined in 40 CFR 51.166	Not found in PAD work scopes	
☐	Motor vehicle fuel		• 40 CFR 80 • 106 *KAR* 1 • 401 KAR 65	ES&HP
☐	Ozone-depleting substances		• 40 CFR 82	
☒	Hazardous substances (CERCLA)	Hazardous substances are designated in 40 CFR 302.4	• 40 CFR 302 • 106 *KAR* 1	ES&HP (MSDS)
☒	Release or threatened release of hazardous substances		• 40 CFR 300 • 106 *KAR* 1	ES&HP
☐	Sale or transfer of federal real property		• 40 CFR 373	
☐	Injury to natural resources resulting from a discharge of hazardous substances		• 43 CFR 11	
☐	Extremely hazardous substances	Extremely hazardous substances are designated in 40 CFR Part 355, Appendix A.	• 40 CFR 355 • 106 *KAR* 1	
☐	Toxic chemicals	Toxic chemicals are listed in 40 CFR 372.65.	• 40 CFR 372 • 106 *KAR* 1	
☐	Hazardous chemicals	Hazardous chemicals are listed in 40 CFR 370.2	• 40 CFR 370 • 106 KAR 1	
☐	Use or storage of restricted use pesticides	Insecticides, fungicides, rodenticides, algicides, and herbicides. Restricted use pesticides are listed in 40 CFR 152.175.	• 40 CFR 171 • 302 KAR 31	
☒	Use or storage of nonrestricted use pesticides	Insecticides, fungicides, rodenticides, algicides, and herbicides	Work planning will identify the appropriate controls	
☒	Point source discharges to surface water		• 40 CFR 122 • 401 *KAR* 4 and 5	Waste Management Plan (WMP)

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	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☒	Nonpoint source discharges (i.e., storm water runoff) to surface water		• 40 *CFR* 122 and 232 • 33 *CFR* 322 and 330 • 401 *KAR* 4 and 5	Field Sampling Plan (FSP)
☐	Oil		• 40 *CFR* 110 and 112 • 401 *KAR* 5	
☐	Hazardous substances (CWA)	Hazardous substances are designated in **40 *CFR* 116.4**	• 40 *CFR* 116 and 117 • 401 *KAR* 5	
☒	Discharges to surface water of toxic pollutants	Toxic pollutants are identified in **40 *CFR* 129.4.**	• 40 *CFR* 122 and 129 • 401 *KAR* 4 and 5	FSP
☐	Discharges to a publicly owned treatment works		Not found in PAD work scopes	
☐	Use or disposal of sewage sludge		• 40 *CFR* 503 • 401 *KAR* 47	
☐	Work in floodplain or wetlands		• 10 *CFR* 1022 • 33 *CFR* 320,323,325, and 330 • 401 *KAR* 4	
☐	Discharges of dredged or fill material to surface waters or wetlands		• 40 *CFR* 232 • 33 *CFR* 320,323,325, and 330	
☐	Structures or work in or affecting navigable waters	Navigable waters are defined in **33 *CFR* Part 329**	• 10 *CFR* 1022 • 33 *CFR* 320,322,325, and 330 • 401 *KAR* 4	
☐	Construction, operation, or maintenance of any structure along or in the Tennessee River or its tributaries		Not found in PAD work scopes	
☐	Injury to natural resources resulting from an oil spill		• 15 *CFR* 990 • 40 *CFR* 112 • 401 *KAR* 4	
☐	Withdrawal of groundwater in Kentucky for remediation or water supply		• 401 *KAR* 4	
☒	Installation or abandonment of a test hole or well	Standards contain requirements for other than water wells.	• 401 *KAR* 6:310	FSP
☒	Waste generation		• 40 *CFR* 260,261, and 262.11 • 401 *KAR* 30, 31, 32:010, Sect. 2	WMP
☐	Infectious waste		Not found in PAD work scopes	
☐	Generation or collection of sanitary-type solid waste		• 40 *CFR* 243 and 244	
☐	Generation of waste high-quality paper or corrugated containers		• 40 *CFR* 244 • 40 *CFR* 246	

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☒	Hazardous waste generation		• 40 CFR 260,261 ,262,265, and 268 • 401 KAR 30, 31, 32, 35, 37, and 40	WMP
☐	Transportation of hazardous waste		• 40 CFR 261 and 263 • 401 *KAR* 31, 33, and 40	
☐	Existing permitted hazardous waste TSD unit		• 40 CFR 264,268, and 270 • 401 KAR 30, 34, 37, 38, and 40	
☐	New hazardous waste TSD unit		• 40 CFR 264,268, and 270 • 401 KAR 30.34.37.38. and 40	
☐	Interim status TSD unit		• 40 CFR 265 • 401 KAR 35, 37, and 40	
☒	Solid waste management units		• 40 *CFR* 264.90-264.101 • 401 *KAR* 34:060, Sects. 1-12	FSP, WMP, Modification
☐	Recycle or reuse of materials		• 40 CFR 247 • 40 CFR 261, 262, and 266 • 40 CFR 761.1, 761.3, 761.20, and 761.30 • 401 KAR 31, 32, 36, and 40	
☐	Waste batteries, pesticides, or thermostats		• 40 CFR 261,262, and 273 • 401 *KAR* 31, 32, and 43	
☐	Used oil		• 40 CFR 261,262, and 279 • 40 CFR 761.1, 761.3, 761.20, and 761.30 • 401 *KAR* 31, 32, and 36	
☒	Solid waste disposal		• 40 CFR 257 and 258 • 401 KAR 30, 40, 45, 47, and 48	FSP, WMP, Modification
☐	Petroleum underground storage tank(s)		• 40 CFR 280 • 401 KAR 42	
☐	Hazardous substance underground storage tank(s)		Not found in PAD work scopes	
☐	Polychlorinated biphenyls		• 40 CFR 761 • 401 KAR 47; 106 ***KAR*** 1 • 40 *CFR* 116 and 117 • 401 *KAR* 5 • 40 CFR 302	
☐	Test rule chemicals	Test rule chemicals are listed in 40 CFR Part 790.	Not found in PAD work scopes	
☐	Export or import of chemical substances		• 40 CFR 707 • 106 *KAR* 1	
☐	Potable water treatment or supply system		• 40 CFR 141,142, and 143 • 401 *KAR* 8	
☒	Injection of material into the subsurface	"Material" includes dye for tests.	• 40 CFR 144 and 146	FSP, WMP, Modification
☐	Injection of hazardous waste into the subsurface		Not found in PAD work scopes	

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	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☐	Asbestos		• 40 CFR 61,257,258, and 763 • 401 *KAR* 45, 57, and 63	
☒	Species of wildlife and plants that are federally listed as endangered, threatened, or of concern	Endangered and threatened wildlife and plants are listed in 50 CFR 17.11 and 17.12.	• 50 CFR 17 and 222	FSP
☒	Species of wildlife that are state listed as endangered, threatened, or in need of management	Lists of Kentucky species are compiled by the Kentucky Nature Preserve Commission and published annually in Transactions of the Kentuckv Academv of Science.	• 301 *KAR* 4	FSP
☒	Species of plant that are state listed as endangered, threatened, or in need of management	Lists of Kentucky species are compiled by the Kentucky Nature Preserve Commission and published annually in Transactions of the Kentucky Academy of Science.	• 301 *KAR* 4	FSP
☐	Sites, buildings, structures, or objects of historical significance	Consult appropriate Cultural Resource Coordinator.	• 36 CFR 60, 63, 65, 78, 79, and 800 • 43 CFR 7	
☐	Alteration to, damage to, or destruction of a facility eligible for listing on the National Register of Historic Places	Consult appropriate Cultural Resource Coordinator.	• 36 CFR 60, 63, and 800	
☐	Nationally significant property that illustrates or commemorates the history or prehistory of the United States	Consult appropriate Cultural Resource Coordinator.	• 36 CFR 65	
☐	Human remains, structures, or artifacts that are at least 100 Years old		• 36 CFR 79,296, and 800	
☒	Excavation		*43 CFR 10 • 401 KAR 5 and 53	**FSP**
☐	Construction on prime farmland		• 7 CFR 658	
☒	Generation, handling, or processing of radioactive materials		• 10 CFR 20.1301 (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 1.a) Any temporary increase in dose limit to be approved by DOE ORO • 10 CFR 20.1101(b) (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 2 only) • 10 CFR 20.1302 (IG DOE Order 5400.5, Chap. 11, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods)	ES&HP, WMP

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☐	Transfer of radioactive material		• IA–Receiver must have an NRC or agreement state license to receive material • 10 ***CFR*** 20.1301 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 1.a) Any temporary increase in dose limit to be approved by DOE ORO • 10 ***CFR*** 20.1101(b) (IA-Criteria provide protection comparable to DOE Order **5400.5,** Chap. 11, Sect. 2 only) ▪ 10 ***CFR*** 20.1302 (IG–DOE Order **5400.5,** Chap. II, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods)	
☒	Radioactive effluent discharges to: air, surface water, ground-water, or a sanitary sewer		• IA–New or increased discharges of radioactive material to active or virgin soil columns are prohibited • 10 ***CFR*** 20.1301 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. II, Sect. 1.a) Any temporary increase in dose limit to be approved by DOE ORO • 10 ***CFR*** 20.1 101**(b)** (IA-Criteria provide protection comparable to DOE Order **5400.5,** Chap. 11, Sect. 2 only) • 10 ***CFR*** 20.1302 (IG–DOE Order 5400.5, Chap. 11, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods) • 10 ***CFR*** 20 Appendix B, Tables 2 & 3 • 10 ***CFR*** 20.2003 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. III, Fig. III-1) • DOE Order **5400.5,** Chap. 111, Fig. 111-3 (IA–Radionuclide DCGs for air immersion only)	ES&HP, FSP (App. A, Table A.1 and Sect. 1.6), WMP

	Activitv/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☒	Low-level waste: treatment, storage, or disposal		• IA–On-site disposal of low-level waste is outside the EMEF work scope • 10 ***CFR*** 20.1301 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 1.a) **Any** temporary increase in dose limit to be approved by DOE ORO • 10 ***CFR*** 20.1 101(b) (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 2 only) • 10 ***CFR*** 20.1302 (IG–DOE Order 5400.5, Chap. 11, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods) • 10 ***CFR*** 20 Appendix B, Tables 2 & 3 • 10 ***CFR*** 20.2003 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. 111, Fig. III-1) • DOE Order **5400.5,** Chap. 111, Fig. 111-3 (IA–Radionuclide DCGs for air immersion only)	WMP
☐	Transuranic waste: treatment, storage, or disposal		• IA–On-site disposal of transuranic waste is outside the EMEF work scope • 10 ***CFR*** 20.1301 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. II, Sect. 1.a) Any temporary increase in dose limit to be approved by DOE ORO • ***10 CFR*** 20.1 101(b) (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 2 only) • 10 ***CFR*** 20.1302 (IG–DOE Order 5400.5, Chap. 11, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods) • 10 ***CFR*** 20 Appendix B, Tables 2 & 3 • 10 ***CFR*** 20.2003 (IA-Criteria provide protection comparable to DOE Order 5400.5, Chap. 111, Fig. III-1) • DOE Order 5400.5, Chap. III, Fig. 111-3 (IA–Radionuclide DCGs for air immersion only)	

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☒	Property containing residual radioactive material		• **40** ***CFR*** 300 • 10 ***CFR*** 20.1301 (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 1.a Any temporary increase in dose limit to be approved by DOE ORO • 10 ***CFR*** 20.1101(b) (IA–Criteria provide protection comparable to DOE Order **5400.5,** Chap. II, Sect. 2 only) • 10 *CFR* 20.1302 (IG–DOE Order 5400.5, Chap. 11, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods)	ES&HP
☒	Release of materials with radioactive contamination		• IA–Materials may be free released if release criteria have been approved by DOE and concurred in by the radiological authority in the receiving state. Any release criteria must meet the public dose limit in 10 ***CFR*** 20.1301. For surface contamination, NRC Reg. Guide 1.86, Table 1, contains consensus release criteria that have been approved by DOE-ORO, NRC, and many states; however, some states may have more stringent criteria. If the Table 1 criteria is not appropriate due to special circumstances, the BJC may request DOE-ORO approval of supplemental limits. There are no consensus release criteria for volumetric contamination; therefore, they must be developed on a case-by-case basis. • 10 ***CFR*** 20.1301 (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. 11, Sect. 1.a)	FSP, WMP

	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used bv SUBCONTRACTOR
	Release of materials with radioactive Contamination (continued)		**Any** temporary increase in dose limit to be approved by DOE ORO • 10 ***CFR*** 20.1101(b) (IA–Criteria provide protection comparable to DOE Order 5400.5, Chap. II, Sect. 2 only) • 10 ***CFR*** 20.1302 (IG–DOE Order 5400.5, Chap. II, Sects. 6.b(1), **6.b(2)(a)** through **6.b(2)(d)** provides consensus methods) • Reg. Guide 1.86, Table 1 (IA–These criteria provide protection comparable to DOE Order 5400.5, Chap. III, Fig. IV-1 and 10 ***CFR*** 835, Appendix D, values for TRU) • 41 ***CFR*** 109-45.5004-1	
☒	Release of materials without radioactive contamination		• IA–Materials may be free released if they have been demonstrated to not contain surface or volumetric contamination resulting from DOE activities	FSP, WMP
☒	Environmental radiological program	Applicable to following A/H/I: a) Generation, handling, or processing of radioactive materials b) Transfer of radioactive material c) Radioactive effluent discharges–air, surface water, groundwater, or a sanitary sewer d) Low-level waste–treatment, storage, or disposal e) Transuranic waste–treatment, storage, or disposal f) Property containing residual radioactive material g) Release of property containing residual radioactive material	• IA–The BJC will use a tailored approach to environmental radiological management systems that addresses the following functions: 1) reduction/minimization 2) characterization 3) segregation 4) acceptance criteria 5) packaging 6) treatment 7) storage 8) disposal 9) environmental surveillance 10) preoperational monitoring 11) meteorological monitoring 12) reporting dose to the public • IG–DOE Order 5820.2A and Draft 10 ***CFR*** 834	WMP
☐	General		• 10 ***CFR*** 1021, NEPA • **42 U.S.C**S S 13101 et seq., Pollution Prevention Act	

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	Activity/Hazard/Issue	Supplemental Criteria	Standards for Paducah (KY)	Work Control Documents to be used by SUBCONTRACTOR
☒	Other Agreements	The current versions of federal, state, or DOE Agreements are Work Smart Standards (i.e., site permits, approval letters, compliance agreements, consent decrees, and executive orders, as applicable).	KPDES KY0004049 Solid Waste 073-00014 073-00015 073-00045 RCRA KY8-890-008-982 Federal Facility Agreement, February 13, 1998	FSP, WMP

APPENDIX D

WASTE MANAGEMENT PLAN
FOR
SIX-PHASE HEATING TREATABILITY STUDY WORK PLAN

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CONTENTS

CONTENTS (continued)

FIGURES

TABLES

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ACRONYMS AND ABBREVIATIONS

BJC	Bechtel Jacobs Company LLC
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
GAC	granular activated carbon
GSA	generator staging area
HP	health physics
IDW	investigation-derived waste
KPDES	Kentucky Pollutant Discharge Elimination System
kV	kilovolt
LLW	low-level waste
M&I	management and integration
PCBs	polychlorinated biphenyls
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
RAAS	Remedial Action Assessment Subcontract
RCRA	Resource Conservation Recovery Act
RFD	Request for Disposal
RGA	Regional Gravel Aquifer
RMA	radioactive material area
SAA	satellite accumulation area
SAIC	Science Applications International Corporation
SPH	Six-Phase Heating
STR	Subcontract Technical Representative
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TRU	transuranic waste
TS	treatability study
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
TSWP	Treatability Study Work Plan
UCRS	Upper Continental Recharge System
WAC	Waste Acceptance Criteria
WGP	Waste Generation Plan
WMP	Waste Management Plan

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1. OVERVIEW

This Waste Management Plan (WMP) is the primary document for management and final disposition of investigation-derived waste (IDW) that will be generated during implementation of a Six-Phase Heating (SPH) Treatability Study (TS) to be conducted near the southeast comer of C-400 Building. This TS is being conducted to determine if this particular technology would be an efficient and effective way to remove trichloroethene (TCE) from the vadose zone, the Upper Continental Recharge System (UCRS) soil, and the Regional Gravel Aquifer (RGA) groundwater. This WMP addresses the IDW management from the point of generation through final disposal or acceptance for interim storage by the Management and Integration (M&I) Contractor. Environmental restoration activities at the Paducah Gaseous Diffusion Plant (PGDP) are managed by the **U.S.** Department of Energy (DOE) M&I Contractor, Bechtel Jacobs Company LLC (BJC). All TS activities (including the waste management activities described herein) will be conducted by the BJC Remedial Action Assessment Subcontractor (RAAS), Science Applications International Corporation (SAIC). Under the RAAS, SAIC will be responsible for all waste management prior to acceptance of the waste by the M&I Contractor for interim storage or final disposal. Standard practices and procedures outlined in this WMP regarding the generation, handling, transportation, and storage of the IDW will comply with all DOE Orders, those BJC procedures referenced in Exhibit "E" of the RAAS Subcontract, Resource Conservation Recovery Act (RCRA) requirements, and/or Toxic Substances Control Act (TSCA) requirements should polychlorinated biphenyls (PCBs) become an issue. If PCBs are present, the SAIC Project Manager will notify the M&I Contractor Subcontract Technical Representative (STR) and shall invoke the change clause. Additional PGDP and DOE waste management guidelines have been incorporated into this WMP.

A copy of this WMP will be available onsite during TS activities. Copies of the plan will be issued to the M&I Contractor STR and to the SAIC Waste Coordinator, who will be responsible for daily oversight of all waste management activities and for ensuring overall compliance with the WMP.

The approach outlined in this WMP emphasizes the following objectives:

- management of IDW in a manner that is protective of human health and the environment;
- minimization of IDW generation, thereby reducing unnecessary costs (e.g., analytical costs) and usage of permitted storage and disposal facilities, which are limited in number;
- compliance with federal, Commonwealth of Kentucky, and DOE requirements; and
- selection of storage and/or disposal alternative(s) for the IDW.

All waste management activities must comply with SAIC procedures, this WMP, and the *Waste Acceptance Criteria for the Department of Energy Treatment, Storage and Disposal Units at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* BJC/PAD-11, Rev 3 (BJC 2001). This document is referred to throughout the rest of this plan as BJC/PAD-11.

During the course of TS activities, including incorporation of enhanced work planning comments and/or changing field conditions, additional PGDP and DOE requirements may be identified. Necessary revisions to the WMP will ensure the inclusion of these additional requirements into the daily activities of waste management personnel.

2. WASTE PLANNING AND GENERATION

2.1 WASTE PLANNING

A Waste Generation Plan (WGP) is required prior to the generation of waste associated with this investigation. This form is in Appendix **A** of the Waste Acceptance Criteria (WAC) document, BJC/PAD-11. Items to be completed per waste stream include the following: the waste stream description; volume (in cubic ft); the type of container to be used, including the number of containers in brackets; the preliminary category; characterization method; analytes; future disposition; schedule; and comments. The information for these items will be located in the *Treatability Study **Work** Plan for Six-Phase Heating, Groundwater Operable Unit, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1889&D2, **(SPH** TSWP) (DOE 2001), this WMP, and/or BJC/PAD-11. The WGP must be signed by the generator; the person filling out the report; the Treatment, Storage, and Disposal (TSD) Facility Manager; and the Waste Operations Manager. If the amount of waste to be produced changes significantly during the course of field activities, a revised WGP will be prepared.

2.2 WASTE GENERATION

A variety of potentially contaminated and noncontaminated types of IDW will be generated during TS activities. All wastes generated from field-related activities have the potential to contain contaminants related to known or suspected past operational or disposal practices. Field activities associated with this **TS** may result in the generation of IDW that must be handled, stored, and disposed of in accordance with applicable Commonwealth of Kentucky, federal, and DOE guidelines. Table D.1 shows the estimated quantities of IDW that may be generated during implementation of the TSWP. The remainder of this section provides a brief description of each waste stream.

Table D.l. Estimation of investigation-derived waste

Waste stream	Volume	Number of containers	Comments
	Solids[a,b]		
Drill cuttings	1,411 ft^3	280	b
Personal protective equipment (PPE) and plastic	215 ft^3	34	b
Excess TS process media	75 ft^3	11	b
Activated Carbon	330,000 lbs	26/17	d,
Misc. noncontaminated construction waste	35 ft^3	5	
Decontamination sludge	17 ft^3	3	h
	Liquids		
Decontamination water	1,900 gal	38	c
Well development water	14,000 gal	255	

“The quantity of laboratory waste is incorporated in the volume of the applicable waste matrix instead **of** being listed as a separate line item.
[b]All containers for solid waste in this table (except activated carbon) are assumed to be 55-gal 1A2/X Drums with 12-mil-thick plastic liner and absorbent pad.
‘The number **of** containers is estimated based on using 55-gal 1A2/X Drums instead of a 1,200 gal tank.
“The containers for granular activated carbon (GAC) contain either 13,000 or 20,000 Ibs., depending on supplier.

2.2.1 Drill Cuttings

Drill cuttings will be generated from the installation of groundwater monitoring wells, electrodes, vacuum monitoring piezometers, and post-test soil borings. It is assumed that all drill cuttings will have a

25% swell factor and that 6.5 ft^3 (i.e., 10% – 12% void space) is placed in each 55-gal drum. All drill cuttings initially will be containerized until the proper disposition is ascertained. In addition, all cuttings will be placed in appropriately labeled drums and managed according to PGDP regulations and procedures.

Seven electrode/soil vapor recovery wells will be installed to a depth of 30 m (97 ft). Assuming a 10% inch auger is used for the drilling activities, there will be approximately 21 m^3 (742 ft^3) **of** drill cuttings generated that will be containerized in approximately 149 55-gal drums.

There will be 4 groundwater monitoring wells that extend to a depth of 35 m (110 ft). Assuming an 8% inch auger is used for the drilling activities, there will be approximately 10 m^3 (345 ft^3) of drill cuttings generated, which will be placed in approximately **67** 55-gal drums.

Fifteen vacuum monitoring piezometers will be installed to the depth of approximately 18 m (58 ft). Assuming a 4%-inch auger is used, approximately 9 m^3 (316 ft^3) of drill cuttings will be containerized in approximately 62 55-gal drums.

In addition, 9 post-test soil borings will be installed to the depth of approximately 18 m **(60** ft). These borings most likely will be installed using direct push technology (DPT) and will generate approximately 0.23 m^3 (8 ft^3) of waste and will be placed in **2** 55-gal drums.

2.2.2 Personal Protective Equipment and Plastic Sheeting

PPE will be worn as required by the Environmental, Safety, and Health Plan (ES&HP) contained in Appendix C of the TSWP (DOE 2001) for personnel performing activities in areas known to be, or suspected of being, contaminated. Before exiting the exclusion zone, personnel will doff and containerize all disposable PPE as potentially contaminated. The PPE will be considered to fall into the same waste classification as the materials with which it came into contact. The PPE will be segregated from aqueous and solid IDW and labeled appropriately. In addition, plastic sheeting used to place drill cuttings and to provide containment/cover from the weather will be packaged and managed as part of this waste stream. The PPE and plastic will be managed by collecting it in a 55-gal 1A2/X Drum and disposing of that waste based on characterization of the drill cuttings by association with related locations. If proper control is not maintained for segregation, the PPE and plastic will be conservatively assumed to be contaminated.

2.2.3 Miscellaneous Noncontaminated Construction Waste

The DOE has implemented waste management activities for the segregation of all clean trash (i.e., trash that is not chemically or radiologically contaminated). Examples of clean trash are office paper, aluminum cans, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items. During implementation of this WMP, all clean trash will be segregated according to the DOE M&I Contractor's guidelines and then collected and disposed of by the SAIC Waste Coordinator once it has been approved for off-site disposal.

2.2.4 Decontamination Sludge

Decontamination sludge will be generated from cleaning drilling and sampling equipment. Liquid will be decanted, to the extent possible, and segregated into the decontamination water waste stream (see Sect. 2.2.6). This sludge will be sampled and managed similar to drill cuttings. It **is** anticipated that two 55-gal drums of waste will be generated during decontamination activities.

2.2.5 Activated Carbon

Activated carbon used on this project will be pre-packaged in ready-to-use containers. Upon arrival, a sample will be taken from each container to establish a radiological baseline for that container. **As** each container is saturated, it will be removed from the system, sampled, and stored in a radioactive material area (RMA). Based upon results of post-use sampling (i.e., "no rad added" or "rad added"), the material will be returned to the vendor for regeneration and reuse or removed from the containers, drummed, and turned over to the M&I Contractor for interim storage as hazardous low-level waste (LLW). It is estimated that 330,000 lb will be used on this project.

2.2.6 Excess TS Process Media

Excess process media that has not been potentially contaminated, such as material removed from mixing equipment, hoses, etc., will be drummed, removed from the site, and disposed the same as other non-contaminated construction waste. Excess media that has been potentially contaminated through use or ground contact will be drummed, sampled, and characterized the same as drill cuttings.

2.2.7 Well Development Water

Well development water will be generated from flushing the four newly generated multi-port groundwater monitoring wells. It is estimated that 1,892 L (500 gal) of water is needed for each port of the monitoring wells that are installed. Therefore, approximately 53,846 **L** (14,000 gal) **of** well development water is expected to be generated. This water will be collected, sampled for characterization, and disposed of according to sample results.

2.2.8 Decontamination Water

Decontamination water will be generated from cleaning drilling and sampling equipment. It is expected that one 55-gal drum of decontamination water will be generated per drilling rig set up. Therefore, approximately 7,190 L (1,900 gal) of decontamination water is expected to be generated. This water will be collected, sampled for characterization, and disposed of according to sample results.

2.3 WASTE MANAGEMENT TRACKING RESPONSIBILITIES

IDW generated during the TS activities at PGDP will require a comprehensive waste-tracking system capable of maintaining an up-to-date inventory of waste. To prevent inappropriate disposal of waste, the tracking system will document generation data and information necessary to determine the amount, if any, of contamination present in the waste so that proper disposal methods can be used. The ultimate disposal method will be the responsibility of the M&I Contractor **STR.** The following sections outline the approach to waste management tracking and M&I Contractor requirements.

2.3.1 Treatability Study Waste Coordinator

The SAIC Waste Coordinator will ensure that all IDW activities are conducted in accordance with the M&I Contractor's requirements and this WMP. The SAIC Waste Coordinator, who will coordinate with TS field personnel and M&I Contractor's Waste Management personnel, will oversee daily waste management operations. The SAIC Waste Coordinator will maintain a Waste Management Logbook, which will contain a complete history of generated waste and the current status of individual waste containers.

Before supplying waste storage containers to the field crews, the SAIC Waste Coordinator will ensure that each container is properly inspected to verify that it meets required specifications and has been properly labeled after transport to the work site (see Sects. **3** and **4).** The M&I Contractor will supply the SAIC Waste Coordinator with Request for Disposal (RFD) forms and attachments and required waste container labels.

Additional responsibilities of the SAIC Waste Coordinator include the following:

- maintaining an adequate supply of labels;
- maintaining drum inventories at sites;
- interfacing with the necessary M&I Contractor's personnel;
- preparing RFDs;
- tracking IDWs;
- ensuring that drums and containers are properly labeled;
- coordinating IDW transfers;
- sampling IDW containers to characterize wastes;
- transferring characterization data to the M&I Contractor's Data Management Coordinator; and
- ensuring Generator Staging Areas (GSAs) and Satellite Accumulation Areas (SAAs) are properly established, maintained, and inspected in the field.

The SAIC Waste Coordinator will update a computer-generated status sheet that can be retrieved quickly and will list all waste generated during TS activities. The Waste Status Sheet will supply information pertaining to the following:

- generation date;
- request for disposal number;
- waste origination point;
- waste type (solid or liquid);
- description (e.g., soil, PPE, plastic);
- quantity of waste;
- current location of waste;
- sampling status;
- sampling results status;
- resampling needed; and
- date released for disposal/to M&I Contractor's interim storage facility.

This status sheet will be supplied to the M&I Contractor STR monthly or whenever necessary to determine the status of a specific site's waste. The M&I Contractor STR will provide a Waste Item Container Log that will be used to document each addition of waste to each container and tank.

The SAIC Waste Coordinator will perform the majority of waste handling field activities. Drum labeling also will be the responsibility of the SAIC Waste Coordinator. This activity will involve coordination with the M&I Contractor's Waste Coordinator. The SAIC Waste Coordinator will perform periodic inspections to verify that drums are labeled in accordance with the WMP guidelines.

Periodically, during the conclusion of work-site activities, the SAIC Waste Coordinator will be responsible for ensuring waste characterization sampling of the IDW containers in accordance with this plan and the procedures outlined in Appendix A (the Sampling and Analysis Plan). When sampling is complete, the SAIC Waste Coordinator will coordinate with the M&I Contractor STR to determine final disposition of all IDW. If interim storage areas become full prior to receiving analytical results, then temporary storage in a 90-day or long-term RCRA storage location will be provided by the M&I Contractor if required. Until the proper analytical or process knowledge paperwork is received, the waste still is the responsibility of SAIC. Similar coordination also will be required if decontamination water from the decontamination pad is moved to the stationary tanks for interim storage.

The SAIC Waste Coordinator also will be responsible for waste characterization sampling of IDW liquids generated during TS activities. This waste will be sampled after being transferred into the waste holding area.

The SAIC Waste Coordinator will complete all chain-of-custody forms relating to the shipment of waste characterization samples. Photocopies of the chain-of-custody form will be made; one will be placed in the project file, and one will be attached to the appropriate RFD form. The chain-of-custody form, along with the associated samples, will be transferred to the personnel responsible for packaging and shipping of waste samples.

The SAIC Waste Coordinator will inspect the decontamination pad to ensure that waste generation is minimized to the extent possible and that the transfer of liquids to the waste holding area is arranged such that the work schedule is not delayed. If improper waste-handling activities are observed, the SAIC Waste Coordinator will notify the M&I Contractor STR and temporarily stop the improper activities. All activities not in compliance with the WMP will be identified and corrected before decontamination activities continue.

2.3.2 Coordination with Field Crews

The SAIC Waste Coordinator will be responsible for daily coordination with all field crews involved in activities that generate IDW. The SAIC Waste Coordinator will perform daily rounds of each of the TS work sites to oversee the IDW collection and will verify that procedures used by the field crews comply with the WMP guidelines. Any improper implementation of procedures will be documented in the Waste Management Logbook, and instructions for proper implementation of procedures will be given to the field crews. Documentation in the logbook during these work-site visits will include work-site location, waste container RFD numbers, type of waste, generation data, and names of personnel at that site.

The M&I Contractor's Waste Coordinator will be involved in scheduling the transfer of waste from the established temporary storage areas (GSA or **SAA)** to interim storage areas. After the M&I Waste Coordinator has approved the transfer of IDW into the waste storage area, the SAIC Waste Coordinator will coordinate the transfer. All the paperwork (RFD; Waste Item Log Sheet; Appendix A, **B,** or C; Process Knowledge Form; or Analytical Waste Variance Form; etc.) will be completed as soon as possible after the waste is generated. The RFD will be submitted to the M&I Contractor's Waste Coordinator before the waste is delivered to the waste storage area. Copies of all RFDs will be maintained in the project file.

Proper disposal of sample residuals resulting from waste characterization samples will be the responsibility of the analytical laboratory.

2.3.3 Coordination with PGDP Waste Management

The SAIC Waste Coordinator will be responsible for coordinating waste management activities with the M&I Contractor's Waste Management Program. The SAIC Waste Coordinator will be available to attend any M&I Contractor-required meetings regarding waste management and handling during project activities.

The SAIC Waste Coordinator will supply the M&I Contractor STR with monthly Waste Status Sheets that summarize the status of each IDW container as well as the area(s) of IDW generation. Additional

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documentation (i.e., RFD sheets, Waste Item Container Log, and the Waste Management Logbook) will be supplied when needed. The SAIC Waste Coordinator will direct the pickup and delivery of the IDW containers.

The RFD forms and appropriate waste container labels will be supplied by the M&I Contractor. The RFD forms will be forwarded to the M&I Contractor's Waste Coordinator when the waste listed on that RFD is delivered to the Contractor for interim storage or final disposal.

The SAIC Waste Coordinator shall be notified by subcontractors before any IDW is transferred from work sites or decontamination pads. When the 4,548 L (1,200 gal) portable tanks have been filled, the M&I Contractor's Waste Coordinator will be notified, in a timely manner, to obtain additional temporary liquid waste storage containers.

All potentially contaminated IDW will be moved to **a** secure designated waste holding area (GSA or **SAA)** in a timely manner.

2.3.4 PGDP Waste Management Training

The SAIC Waste Coordinator and all field personnel will be required to attend the PGDP Waste Management Training Program. The 2.5-hour training session will address requirements for the proper segregation and disposal of wastes at PGDP.

3. IDW REQUEST FOR DISPOSAL, LABELING, AND STORAGE

All waste management activities must comply with SAIC procedures, this WMP, and the WAC, BJC/PAD-11.

3.1 IDW RFD FORMS

SAIC will complete the generation portion of the RFD form prior to shipping or transferring waste to the M&I Contractor. The RFD form is used as an internal manifest system. It is used along with supporting documentation [e.g., container log sheets, health physics (HP) radiological surveys, analytical data, LLW form, RCRA Mixed or PCB/Radioactive Waste form, Industrial Landfill Waste form, and the Waste Variance form) to provide a historical record of the waste generation activity and to compare it to the applicable WMP and WGP. The RFD form and several of the supporting documentation forms are presented in Appendix I of BJC/PAD-11.

SAIC will provide a consistent waste description for field "W28" of the RFD form. The description will be "SPH TS IDW; (Waste Stream Description as presented in this WMP); [Specific Generation Location (e.g., monitoring well number and depth of cuttings)]; and any other specifics that will help facilitate treatment and/or disposal."

3.2 IDW LABELING

SAIC will label and mark all containers consistent with information provided in the approved WGP. All waste containers will have the following labels and marking: waste container label, DOE waste label,

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appropriate waste category labels, RFD number with appropriate date and contents written on the container in permanent marker, and HP Survey tag (if applicable). The placement of labels and markings is presented in Appendix D of BJC/PAD-11. In addition, if the waste category is RCRA hazardous mixed waste, the "Rad Label" will be affixed above the "DOE Label" as presented for LLW. If upon receipt of the analytical data and subsequent characterization, it is determined that the initial waste category is incorrect, the incorrect labels will be removed and the correct labels will be placed on the container.

3.3 IDW STORAGE

The SAIC Waste Coordinator will get GSAs and **SAAs** established for this project as required in Procedure **RAAS-008,** "Waste Generator Responsibilities for On-Site Temporary Storage of Waste Materials." SAIC anticipates the GSAs and **SAAs** to be at the C-752-C or C-416 areas. Since the work site is in a secured area, short-term storage of waste drums at the work site will be permitted.

The current storage facilities for Environmental Restoration waste at PGDP are the C-752-A and C-746-H3 Environmental Restoration Waste Storage Pads. These areas can be used to store nonhazardous waste, with no storage time limitation. The C-746-H3 storage pad also can be used to store hazardous waste for <90 days. After **90** days, the waste can be placed in the C-746-A, C-746-Q, or C-733 RCRA Hazardous Waste Storage Areas. It is possible that some of the generated waste may be hazardous or mixed waste.

4. TRANSPORTATION OF IDW

The area where **SPH** TS activities will be conducted is located within the secured area of the PGDP. It is anticipated that most of the IDW generated will be temporarily stored at the C-416 decontamination area until final disposition is determined. All waste management activities must comply with SAIC procedures, this WMP, and BJC/PAD-11.

4.1 REQUIRED EQUIPMENT

The movement of drums and characterized or uncharacterized water storage tanks will be the responsibility of SAIC. SAIC will place IDW containers at each work site before investigation activities begin.

Equipment that will be used to move IDW first must be inspected by SAIC and M&I Contractor personnel. Any equipment not meeting the requirements of this inspection will not be released for use during any **TS** activities until corrective actions have been made and approved.

Types of equipment planned for use as part of the transportation process will include items such as stake-bed trucks (1 ton or larger), flat-bed trailers (capable of hauling four or more drums), and forklift trucks (able to maneuver effectively on hard surfaces and grass-covered areas). Straps will be used to secure drums to the vehicles during the transportation process. The Waste Management Procedure RAAS-017, "Opening Containerized Waste," will be followed whenever drums are handled.

4.2 CONTAINERIZATION AND TRANSPORTATION OF SOLID IDW

Containerization of all solid IDW will be in accordance with Sect. 5 and App. B of BJC/PAD-11. Solid IDW will consist of soil cuttings from drilling operations, miscellaneous construction debris, and decontamination sludge. In addition, compactable waste (i.e., PPE) will be transported from work sites as described in the following text.

4.2.1 Types of Containers

Solid waste must be containerized in **U.S.** Department of Transportation (DOT) lA-2X drums or approved equivalents that are lined with a minimum 12 mil- (0.47244 inch-) thick plastic liner. SAIC will minimize the amount of free liquid. Any substantial amounts of free liquid will be decanted and placed in an approved container. Any residual amount of aqueous liquids in a drum of solid waste must be solidified. If the anticipated final disposition of the waste is interim storage then Stergo®, an absorbent granular material manufactured by Corpex Technologies, Inc., or a M&I Contractor-approved equivalent, will be added to the drum. If the anticipated final disposition of the waste is the M&I Contractor's Landfill or commercial disposal, then a commercial dehydrated granular clay absorbent material will be added to the drum. The amount of granular absorbent used and the placement of absorbent within each drum will be in accordance with the manufacturer's recommendations. Stergo® or clay material will not be used to solidify nonaqueous liquids.

All containers containing solids will not exceed **88%** of capacity.

4.2.2 Transportation of Containers

When loading the drums for transport, forklift operators will use drum grabbers to place the drums onto the truck or flat-bed trailer. Other methods for loading the drums will not be allowed. After the drums are loaded, they will be strapped together and secured to the vehicle. Care will be taken when the drums are moved from the site onto the transportation vehicle or off the vehicle onto wooden pallets at the waste storage pad. Because public roads may be crossed, the exterior of the containers and pallets on which the containers are sitting will be completely cleaned of mud and debris before they are removed from the work site.

Movement of carbon containers will be performed with equipment specifically designed for moving them and by personnel properly trained in the operation of this equipment.

4.3 CONTAINERIZATION AND TRANSPORTATION OF LIQUID IDW

Liquid IDW will consist of well development and decontamination water generated at the decontamination pad and the TS site. Methods for containerization and transportation are described in the following text.

4.3.1 Types of Containers

All waste management activities must comply with SAIC procedures, this WMP, and BJC/PAD-11. Liquid IDW will be transported in 4,548 L (1,200 gal) mobile tanks and will be transferred into either 4,548 L (1,200 gal) portable or 9,475 L (2,500 gal) stationary tanks. A Waste Item Container **Log** will be maintained for each tank showing the history, generation date, analyses performed, and source of the waste water. The tanks will not be filled to more than 90% of capacity.

In addition, liquid IDW will be stored in 208 L (55 gal), 1A1 DOT-approved, closed-top drums approved for storage of liquids. A minimum of 7.62 cm **(3** in.) of headspace will be maintained in all 208 L (55 gal) drums used for storing liquid wastes to allow for expansion of the contents.

4.3.2 Transportation of Containers

Mobile tanks supplied by the M&I Contractor will require a vehicle equipped with an appropriate hitch as well as wiring used to operate the trailer lights. Before any liquid IDW is transported, the SAIC Waste Coordinator will ensure that the trailer lighting system is functioning properly and that the tires are properly inflated. If problems with the trailer are identified, the M&I Contractor's Waste Coordinator will be notified so that replacement or repairs can be arranged. The transportation of 55-gal drums containing liquid IDW will follow the same procedures as those discussed for drums containing solid IDW. Drums containing liquid IDW will not be stored on the same pallet as drums containing solid IDW except during transportation.

5. SCREENING OF TS ANALYTICAL SAMPLES

During the course of treatability study field activities, screening of samples in the field and in an on-site laboratory will be performed routinely to protect the health and safety of on-site personnel and to ensure compliance with regulatory guidelines. All samples to be shipped offsite for laboratory analyses will be screened for radiation at an on-site laboratory before shipment and will receive approval for off-site analysis.

5.1 FIELD SCREENING

Field screening for health and safety will be conducted during project field activities and sample collection. The field screening to be performed will incorporate the use of an organic vapor analyzer, organic vapor meter, or HNu equipment to monitor organic vapors as well as radiation meters capable of detecting alpha and beta/gamma radioactivity. ***An*** elevated reading from any field monitoring will be cause for a reevaluation of the current waste categorization, labeling, and handling activities.

5.2 ON-SITE LABORATORY RADIATION SCREENING

The PGDP on-site laboratory will analyze all waste characterization samples. Screening for off-site shipment is not anticipated for this **TS.**

All samples that must be shipped offsite for analysis first will be screened for radiation so that DOT limits will not be exceeded. Currently, the limit on specific activity is < 2.0 µCi/ml for liquid wastes or < 2.0 µCi/g for solid wastes.

If screening results are below the DOT limit, the PGDP will approve shipment of the samples offsite to the approved laboratory for the requested analyses. Samples with radioactivity levels < 2.0 µCi/ml for liquid wastes or < 2.0 µCi/g for solid wastes will not be allowed offsite.

6. IDW CHARACTERIZATION, SAMPLING, AND ANALYSIS

Wastes generated from sites designated as potentially contaminated will be sampled and analyzed to characterize and classify them for proper laboratory handling, record keeping, transfer, storage, and disposal. Waste analyses will **be** performed using **U.S.** Environmental Protection Agency (EPA)-approved procedures,

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as applicable. Analysis required for hazardous waste classification will reference EPA SW-846. Waste-water analysis will reference Clean Water Act and/or Safe Drinking Water Act procedures. Quality Assurance/ Quality Control (QA/QC) requirements and data management requirements as specified in the Quality Assurance Project Plan (QAPP) [Appendix B of the SPH TSWP (DOE 2001)] and the Data Management Plan [Sect. 7 of the SPH TSWP (DOE 2001)] will be followed for all waste characterization sampling activities.

Characterization information and guidance is provided in BJC/PAD-11 and Exhibit "E" of the Contract between SAIC and the M&I Contractor (hereafter referred to as the "Contract"). The **SAIC** Waste Coordinator will coordinate with the M&I Contractor's Waste Coordinator and the M&I Contractor's Sample Management Officer for required analysis collection and transfer of characterization samples to a fixed-base laboratory.

6.1 IDW CHARACTERIZATION

Based on sample analyses, the IDW will be classified into one of the following categories: RCRA hazardous waste; PCB waste; transuranic waste (TRU); LLW; mixed waste; and non-hazardous waste.

6.1.1 Resource Conservation and Recovery Act Hazardous Waste

The IDW will be classified as a RCRA hazardous waste if it meets one of the two following criteria.

1. The IDW contains an EPA-listed hazardous waste identified in 40 Code of Federal Regulations (CFR) 261.31 through 261.33.
2. The IDW exhibits characteristics of hazardous wastes, including ignitability, corrosivity, reactivity, or toxicity as described in 40 CFR 261.21 through 261.24.

To determine whether a waste is RCRA listed, its source must be identified. Site information, such as storage and disposal records, manifests, and spill reports will be used to determine source identity. When such documentation is unavailable, it will be assumed that the wastes are not RCRA-listed hazardous wastes (EPA 1992). If documentation confirms the IDW contains RCRA-listed waste from a process, spill, or disposal that occurred after the effective date of RCRA regulations (November 19, 1980), the IDW will be managed as a hazardous waste in accordance with the EPA Contained-In Policy. This policy requires any mixture of a nonsolid waste (environmental media) and a RCRA-listed hazardous waste to be managed as a hazardous waste as long as the material contains the listed hazardous wastes above health-based standards.

The following procedure (as outlined in Fig. D.1) will be used to determine which, if any, of the SPH TS-generated IDW is RCRA waste.

- The IDW will be appropriately containerized onsite and documented properly (through the use of fix-on labels and other records listing the source, date, and type of material).
- The IDW containers will be moved to the designated waste holding area for temporary storage.
- The analytical results from the characterization samples collected during implementation of this WMP will be compared with the total analysis regulatory limits listed in Appendix F of BJC/PAD-11. If the analytical values from the samples are less than the total analysis regulatory values, the corresponding IDW will be assumed to be non-RCRA waste and will remain at the designated waste holding area until final disposal.

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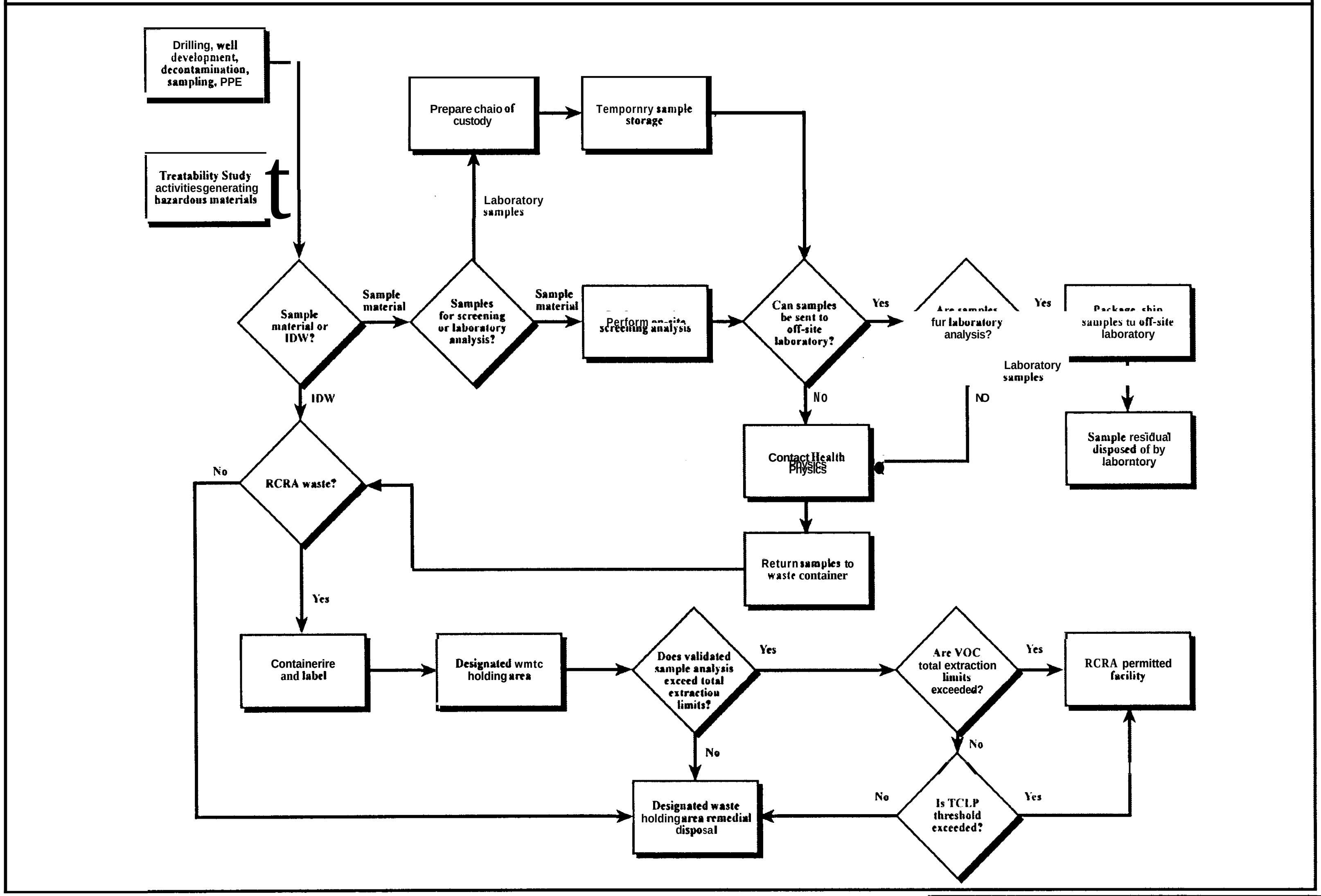

U. S. DEPARTMENT OF ENERGY DOE OAK RIDGE OPERATIONS PADUCAH GASEOUS DIFFUSION PLANT
BECHTEL JACOBS COMPANY, LLC MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700 Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio
Science Applications International Corporation P O Box 2502 Oak Ridge, Tennessee 37831

Fig. D.l. Sample and IDW management.

- For sample analytical values that exceed the total extraction limits or where samples/parameters were not analyzed for total analysis regulatory limits, a Toxicity Characteristic Leaching Procedure (TCLP) will be run on the corresponding IDW. If the samples exceed the TCLP regulatory limit (Appendix F of BJC/PAD-11), the IDW will be managed as RCRA waste. If the TCLP regulatory limits are not exceeded, then the IDW will remain at the designated waste holding area until final disposal.

- If the total analysis regulatory limits exceeded include volatile organics then, because of holding time limitations for volatile organics, the IDW will be managed as RCRA waste.

- Analytical data will be used to make recommendations on the disposition of drill cuttings. For example, if none of the soil collected exceeds the total extraction limits in Table 1.1, Exhibit E, of the RAAS subcontract, the soils generated during the excavation activities (e.g., drilling) will not be considered RCRA waste.

The authority for using this method of evaluating the need for further testing is 40 CFR Part 261, Appendix 11, Method 1311, "Toxicity Characteristic Leaching Procedure," Item 1.2, which states, "If **a** total analysis of the waste demonstrates that individual contaminants are not present in the waste, or that they are present but at such low concentrations that the appropriate regulatory thresholds could not possibly be exceeded, the TCLP need not be run."

6.1.2 PCB Wastes

The IDW will be classified based on threshold levels of PCB concentrations in the solid or liquid waste, not on PCB concentrations of the original source material. Any IDW that contains PCBs between the practical lowest level of detection in the waste matrix (i.e., 0.1 ppb in water and 1 ppm in soil) and less than 50 ppm shall be classified as PCB-detectable waste. Any waste that equals or exceeds 50 ppm shall be classified as PCB waste. Based on previous analytical data, it is not expected that PCB-detectable waste or PCB waste will be encountered during the SPH TS.

6.1.3 TRU Wastes

TRU wastes are those that are contaminated with elements that have an atomic number greater than **92,** including neptunium, plutonium, americium, and curium that are in concentrations greater than 100nCi/g. Although it is possible that TRU elements may be detected in the SPH TS, it is unlikely that any of the waste generated during this **TS** will be above the threshold limit. Previous analytical data is available to make this determination.

6.1.4 Low-Level Wastes

LLWs are described as any nonhazardous, non-PCB, or non-TRU waste containing radioactivity or other radionuclides in a concentration greater than the latest off-site release criteria and are not classified as high-level waste, TRU waste, spent nuclear fuel, or byproduct material. LLWs will be generated in the SPH **TS.** All waste have the potential to be classified as LLW for this project.

6.1.5 Mixed Wastes

Mixed wastes are any materials that have been classified as hazardous and/or PCB wastes and that are also classified as LLW and/or TRU waste. It is possible that mixed wastes will be generated during the SPH TS. Possible mixed waste streams include drill cuttings, decontamination sludge, development water, and decontamination water.

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6.1.6 Nonhazardous Wastes

IDW that does not meet the classification requirements of RCRA hazardous wastes, PCB wastes, LLW, TRU waste, or mixed wastes will be classified as nonhazardous waste.

6.2 SAMPLING AND ANALYSIS OF IDW

The SAIC Waste Coordinator will be responsible for sampling the solid and liquid IDW as needed. During sampling, all appropriate health and safety concerns will be addressed. Sample materials from different containers will not be mixed, and only containers requiring further characterization will be sampled. Table **D.2** summarizes waste characterization requirements. The sampling procedures for waste characterization are described in the following text.

6.2.1 Solid IDW

The analytical results for IDW will be compared with the total analysis regulatory limits in Table 1.1 of Exhibit “E” for RCRA classification and to the limits in Table 1.4 of Exhibit “E” of the Contract to support classification efforts for TRU wastes, LLW, and PCB wastes. If the total analysis results are less than the levels presented in Table 1.1, then the soil IDW will be considered non-RCRA waste and will require no further sampling. If the results exceed the values in the table or total analysis data is not available, the IDW will be considered a potential RCRA waste and must be sampled for the TCLP parameters listed in Table 1.3 of Exhibit “E” of the Contract.

6.2.2 Aqueous IDW

All liquid waste samples will be collected directly from the 9,475 L (1,200 gal) stationary tanks or 4,548 **L** (1,000 gal) mobile tanks located in the secured storage area. One sample will be collected from each tank when the tank has reached capacity. This sample will be analyzed for oils, grease, PCBs, and radionuclides only.

Samples will be collected either by filling a sample container directly from a drain valve near the base of the tank or by collecting a sample from a port at the top of the tank. Collecting samples from the drain valve is the preferred method but will be conducted only if the drain valve is high enough from the ground to allow containment of any spilled material. Equipment for both sampling methods will be available during sampling episodes. One duplicate sample will be obtained for every 20 samples collected.

After initial characterization results are obtained, waste water determined to be within the appropriate Kentucky Pollutant Discharge Elimination System (KPDES) discharge limits will be processed to remove total suspended solids to an acceptable level and transferred to a 20,000 gal. storage tank. Once full, the 20,000 gal. tank will be sampled for complete characterization as specified in Table 1.4 of Exhibit “E” of the contract. Waste water that is below KPDES outfall discharge limits will be discharged to the designated KPDES outfall after National Environmental Policy Act approval. Waste water above KPDES outfall discharge limits and TCLP regulatory limits will be treated to levels below KPDES outfall limits by the M&I Contractor and discharged within 90 days of receipt of the waste characterization results. Waste water that fails the TCLP and cannot be treated for KPDES discharge within **90** days will be stored in accordance with applicable regulations until KPDES discharge limits can be achieved or an alternate disposal method is determined.

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Table D.2. Summary of IDW sampling and analysis for the Six-Phase TS

Waste Stream	Volume	Sample Requirements	Solid	Liquid	Analytical Requirements
SOLIDS	**(Drums)**				
Drill cuttings	280 (4 roll-offs)	a5 (one 5-point composite sample per roll-off)	4	N/A	Exhibit "E" Tables 1.1, 1.2, and 1.3 of the RAAS Contract.
PPE and plastic	31	None	NA	NA	Based on associated drill cuttings analytical data
Excess TS process media	11	None	NA	NA	Process knowledge
Misc. non-contaminated construction waste	5	None	NA	NA	Process knowledge
Decontamination sludge	2	1/drum	2	N/A	Tables 1.2 and 1.3 of "Exhibit E" of the RAAS Contract
GAC	17 20,000 lbs container	2 composite per container	34	N/A	Table 1.2 of Exhibit "E" of the RAAS Contract.
LIQUIDS	**(Gals)**				
Monitoring well development	14,000	1/1,200 gal	N/A	121 1	12-Oil, grease, & PCBs only. 1-Table 1.4 of "Exhibit E" of the RAAS Contract
Decontamination water	1,900	1/1,200 gal	N/A	2/ 1	2-Oil, grease, & PCBs only. 1-Table 1.4 of "Exhibit E" of the RAAS Contract
QA/QC SAMPLES					
Field equipment blanks	N/A	1/20 samples	N/A		Table 1.4 of "Exhibit E" of the RAAS Contract
Trip blanks	N/A	[b]	N/A	7	**VOCS**
Field duplicates	N/A	[c]	9	1	Same as original sample
TOTAL			178	15	

"If field radiological surveys dictate, drums of drill cuttings will be emptied into 20 yd^3 roll-offs. Each roll-off will be sampled by collecting one 5-point composite sample from each roll-off for complete analysis.
[b]One trip blank per shipment container with VOC sample material.
[c]One field duplicate for every 20 samples per waste matrix (i.e., solids and liquids). If debris waste were to be sampled, it would need a separate field duplicate than the one for solids because the collection method would differ.

7. SAMPLE RESIDUALS AND MISCELLANEOUS WASTE MANAGEMENT

Sample residuals will be disposed of by the contracting laboratory.

8. WASTE MINIMIZATION

Waste minimization requirements that will be implemented, as appropriate, include those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, and 435.1; and the M&I Contractor. Requirements specified in the M&I Contractor's WMP regarding waste generation, waste tracking, waste reduction techniques, and the waste reduction program, in general, also will be implemented.

To support the M&I Contractor's commitment to waste reduction, an effort will be made during all field activities to minimize waste generation as much as possible, largely through ensuring that potentially contaminated soils are localized and do not come into contact with any clean media that could create more contaminated waste. Waste minimization also will be accomplished through waste segregation, selection of PPE, and waste handling (spill control).

Solid wastes such as Tyvek coveralls and packaging materials will be segregated. An attempt will be made to separate visibly soiled Tyvek coveralls from unsoiled ones. In some instances, partially soiled coveralls can be cut up and segregated. Other solid waste will not be allowed to contact potentially contaminated drill cuttings. Efforts will be made to keep Tyvek coveralls clean, reuse clean coveralls, and wear coveralls only when absolutely necessary. Proper waste handling and spill control techniques will help minimize waste, particularly around the decontamination areas where decontamination water must be contained. In addition, hoses used in the decontamination area will not be permitted to leak, which would create additional waste water that would require disposal.

9. HEALTH AND SAFETY ISSUES RELATED TO IDW ACTIVITIES

Health and safety procedures will follow the ES&HP [contained in Appendix C of the SPH TSWP (DOE 2001)] used by field crews during site-specific activities. Health and safety issues pertaining to waste management at the PGDP are addressed in the ES&HP.

10. REFERENCES

BJC (Bechtel Jacobs Company LLC) 2001. *Waste Acceptance Criteria of the Department of Energy Treatment, Storage, and Disposal Units at Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* BJCIPAD-11, Rev. 3, Bechtel Jacobs Company LLC, Kevil, KY, March.

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EPA 1994. *Test Methods for Evaluating Solid Water, Physical/Chemical Methods,* Third Edition, SW-846, U.S. Environmental Protection Agency, Washington DC, November.

DOE 2001. *Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1889&D2, August.

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APPENDIX E

DERIVATION OF TCE AND ''Tc SOURCE ZONE VOLUMES
FOR THE WAG 6 AREA
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY

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DERIVATION OF SOURCE ZONE VOLUMES

TNTRODUCTION

The WAG 6 Remedial Investigation (RI) collected subsurface soil and water samples from 133 boreholes within and adjacent to the C-400 block. As anticipated and documented in this calculation package, the data confirm that the C-400 area contains the primary sources of trichloroethene (TCE) and ^{99}technetium (^{99}Tc) to the Northwest Plume and a plume trending east from the north corner of the C-400 block. Useful characterization data are largely derived from soil samples in the UCRS and water samples within the RGA.

Taken together, the data indicate the presence of four discrete sources of TCE and two discrete sources of ^{99}Tc near C-400. In addition, there is a diffuse source of ^{99}Tc on the east side of the C-400 building and an undefined source of ^{99}Tc south of the C-400 block that impacts water quality in the lower RGA on the east side of the C-400 Building.

TCE DNAPL SOURCE ZONES

This analysis of the WAG 6 data infers the presence of four TCE DNAPL source zones located: 1) at the site of a former TCE transfer pump (southeast C-400 block), 2) along the storm sewer at the C-400 Leak Site/SWMU 11 (southeast C-400 block), 3) along the storm sewer exiting the south end of the C-400 Building (southwest C-400 block), and 4) beneath the C-403 Neutralization Pit/SWUM 40 (northeast corner C-400 block).

Only the southeast corner of the C-400 block is sufficiently sampled in 3-dimensions to map/model TCE levels within the UCRS DNAPL zone. Because no meaningful data regarding TCE levels in RGA soils could be collected by the WAG 6 RI, the depth and width of the RGA source zone must be inferred from the dimensions and vertical trends of the resulting dissolved-phase plumes and conceptual models. Appendix A presents isoconcentxation maps of TCE in soil for the southeast C-400 block.

For the DNAPL source zone associated with the C-400 Building southwest storm sewer, the UCRS soil data define TCE in soil concentrations near the edge of the DNAPL zone and a perimeter of very low to nondetect levels of TCE in soil. Appendix B presents the TCE-in-soil analyses for this area. The presence of DNAPL at the C-403 Neutralization Pit (SWMU 40) is inferred solely from levels of dissolved-phase TCE, both in the RGA and in water that collected within the C-403 Neutralization Pit during the RI.

"TECHNETIUM SOURCE ZONES

The dimensions of the ^{99}Tc source zones in the UCRS are based on conceptual models. Too few ^{99}Tc analyses resulted from the WAG 6 RI. However, the plot of dissolved beta activity to ^{99}Tc activity shows a strong, near 1:1, relationship (Figure 1). The RI provides sufficient analyses of dissolved beta activity to map the primary ^{99}Tc source to the Northwest Plume in the northwest corner of the C-400 block. This source zone is south of the Waste Discard Sump/SWMU 203 (located at the northwest corner of the C-400 Building). The former Technetium Storage Tank/SWMU 47 appears to be the likely remaining candidate spill source. Elevated ^{99}Tc activity in soil was detected in soil borings at the former tank location.

Dissolved beta activity suggests a second discrete source of ^{99}Tc exists at the northeast corner of the C-400 Building. The C-403 Neutralization Pit/SWMU 40 appears to be the ^{99}Tc source. High dissolved ^{99}Tc activity has been reported from a shallow well adjacent to C-403. The water that collected in the C-403 Pit during the RI had high beta activity.

The upper RGA on the east side of the C-400 Building has a near uniform beta activity of 100-200 pCi/L. This activity appears to be derived from a diffuse source. The fan room plenum basement on the east side of the building is a potential release mechanism with appropriate size to generate an UCRS source with low activity.

Much higher dissolved beta activity, 800-900 pCi/L appears near the base of the RGA on the east side of the C-400 Building. This increase in beta activity appears to be due to a separate plume flowing into the C-400 area from the south. The source of this plume remains undefined.

DISSOLVED PHASE PLUMES

Appendix C provides TCE isoconcentration contour maps and beta isoactivity contour maps of the RGA in the C-400 area. Previous interpretations of the groundwater contaminant plumes at PGDP, consistent with the present interpretation, indicate significant lateral and vertical development of the plumes. Consequently, the data set was discretized vertically to generate 'slice' maps. As determined by the sampling frequency, the dissolved phase contaminant levels are grouped for mapping in five ft thick intervals between the elevations of 285 ft and 315 ft above mean sea level.

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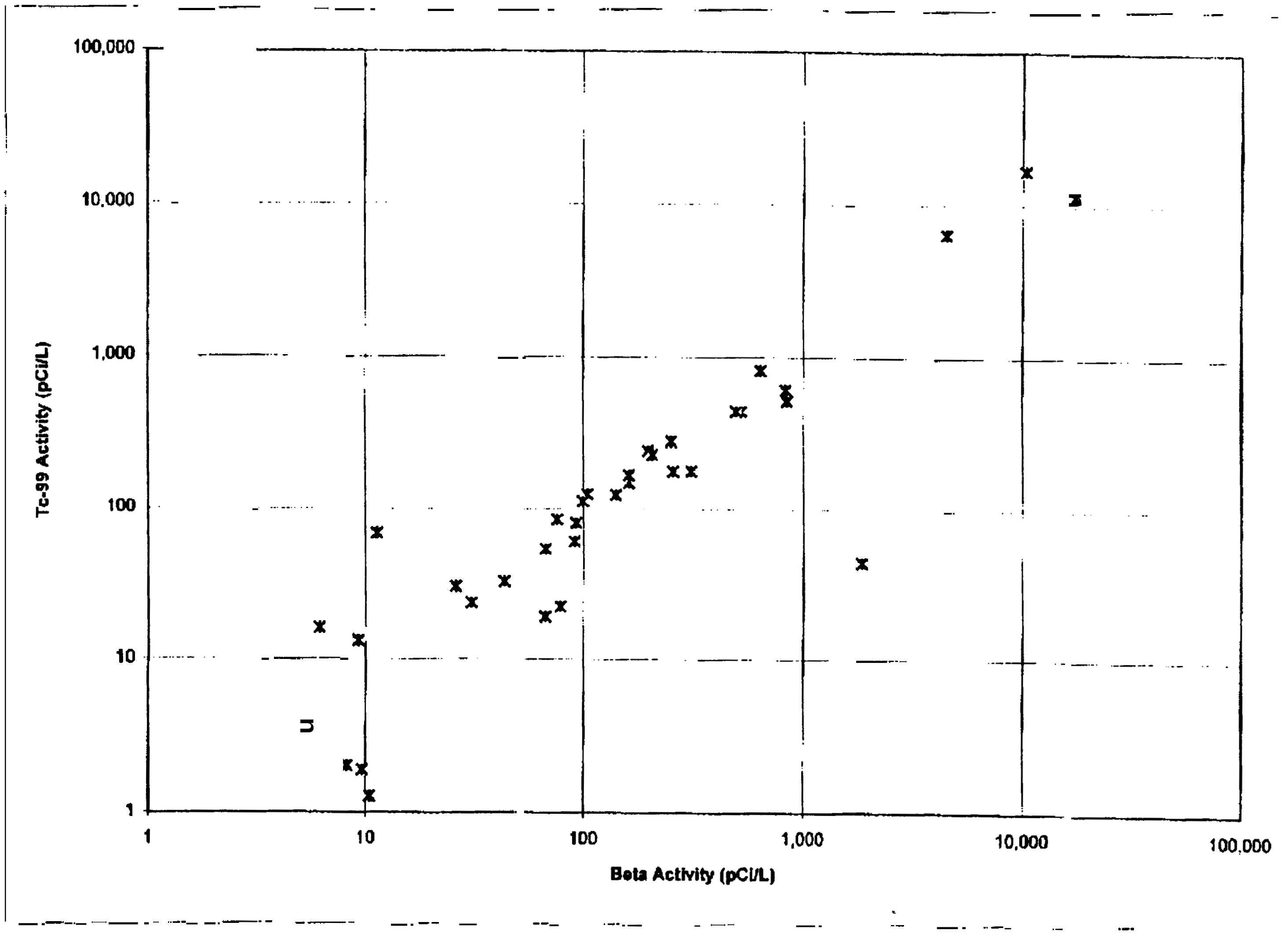

Figure 1. Plot of Dissolved Beta Activity Versus Dissolved Technetium-99 Activity from the WAG 6 Data Base

To constrain the possibilities regarding the number and locations of source areas and location and orientation of plumes, *these* maps have been contoured to be compatible (flow directions inferred from dissolved TCE trends match flow directions inferred from dissolved ^{99}Tc trends). *An* additional constraint placed on the contour maps was that the inferred flow direction could not significantly change between adjacent depth intervals. Thus, data from adjacent depth intervals biases the contour interpretation, maximizing the use of the available data.

Vertical flow predominates in the UCRS and has significant impact in the uppermost RGA, where the sediments typically are finer grained than the middle and lower RGA (interpreted to mean the upper RGA has a lower hydraulic conductivity than the middle and lower RGA). Thus, the high contaminant: levels in the top 'slice' interval mark the entry point of the DNAPL or core of dissolved contamination into the RGA and help to point to the spill location.

Lateral trends of the main contaminant plumes sourced in the C-400 area are well developed in the next lower interval, 305.0 - 309.9 ft. With increasing depth, the impact of the shallow DNAPL sources are diminished and the areal extent of the high concentration TCE core of the plume becomes smaller.

DEPTH OF MIGRATION OF TCE DNAPL

As interpreted by these vertical trends, the C-403 DNAPL source is constrained to the UCRS. (This site impacts dissolved phase TCE levels only down to an elevation of 310 ft). It appears that the DNAPL source zones associated with the TCE *Leak Site/ SWMU 11* and the south-end storm sewer penetrate to the upper RGA. (These sites influence dissolved phase TCE levels down to an elevation of 300 ft.) TCE, as DNAPL, from the TCE transfer pump appears to have migrated *to* the base *of* the RGA where a small DNAPL pool has formed. (TCE levels in nearby boring 400-037 increase at the base of the RGA.)

DEPTH OF ^{99}TECHNETIUM SOURCE

Dissolved-phase beta activity is limited to the upper RGA beneath C-403, suggestive of a source term in the UCRS. This is consistent with the expected behavior of ^{99}Tc. The high solubility of ^{99}Tc in oxidized water, such as the RGA, would tend to inhibit the development of a secondary source in the RGA.

The depth of penetration of the ^{99}Tc *source* tentatively associated with the Technetium Storage Tank (SWUM 47) remains uncertain.

Here, the dissolved-phase beta activity penetrates to the base of the RGA. One possible interpretation is that the oil containing the ^{99}Tc concentrate (a mixture of polyaromatic hydrocarbons) also was a DNAPL that has penetrated to the base of the RGA. No indications of a polyaromatic hydrocarbon source are known from the northwest C-400 Building area. Presumably, these oils have very low solubilities that would not result in an appreciable dissolved-phase plume of polyaromatic hydrocarbons.

DNAPL VOLUME CALCULATION IN THE UCRS

Southeast C-400 Block (TCE Transfer Pump and TCE Leak Site/ SWMU 11 Source Zones

Table 1 summarizes the soil textures described from boring 400-207. This boring is being used to represent the geology of the UCRS for the source zones in the southeast C-400 area. The assumed porosity for the UCRS sediments is the mean of measurements from 16 UCRS samples collected for the WAG 6 RI.

Table 1. Summary of UCRS Properties in the Southeast C-400 Area

Depth Interval (ft)	Elevation of Base of Interval (ft)	Representative Lithology	Assumed Porosity (%)
0-33	346	silt to silty clay	36
33-45	334	gravely sand	36
45-57	322	silty sand to fine sand	36

For the purpose of calculating a TCE DNAPL volume in the UCRS for the southeast C-400 block, the maps of Appendix A have been used to define the area containing soil with 100 µg/g ox greater TCE. Assuming the density of the TCE DNAPL is 1.46 g cm^3, the specific gravity of the UCRS soil grains is 2.65 g/cm^3, and the soil has a porosity of 36% with a 0.1% DNAPL saturation, the associated soil TCE concentration is 308,948 µg/Kg or 309 µg/g. Thus, the maps define the area containing soils with approximately 0.1% saturation and greater.

> Note: In *Estimating Potential for Occurrence of DNAPL* at Superfund *Sites* (EPA, 1992), a DNAPL saturation of 1% in soil is presented as an indication of DNAPL presence. The use of a 0.1% saturation level to define the DNAPL zone is due to the limits of resolution capable with the data set. The WAG 6 RI analyzed soils from the southeast C-400 block with greater than 1% DNAPL saturation.

The approximate area for each depth interval slice is presented in Table 2.

Table 2. Area and Volume of the TCE DNAPL Zone in the UCRS in the Southeast C-400 Area

Depth Interval (ft)	Area Containing 100 PPM TCE or Greater (ft^2)	Thickness Represented (ft)	Volume Represented (ft^3)
365.0 - 369.9	4,000	14*	56,000
360.0 - 364.9	3,400	5	17,000
355.0 - 359.9	5,070	5	25,350
350-0 - 354.9	3,730	5	18,650
345.0 - 349.9	2,500	5	12,500

Characterization data from the original SWMU 11 investigation and the WAG 6 and WAG 27 RIs all suggest the DNAPL migration pathways through the UCRS are essentially straight down. This is consistent with the general texture of the UCRS silts and clays which have no observable lateral-to-vertical anisotropy. Thus, the 'footprint' of the leak source is the width of the source zone with highest DNAPL saturation.

The distribution of TCE levels in the southeast C-400 block suggests the TCE concentration declines near-logarithmically with distance from the DNAPL migration pathway, Several assumptions have been made to derive a representative DNAPL saturation of the source zone:

- The DNAPL volume in the area containing less than 100 µg/g (~0.1% saturation) of TCE in soil is insignificant.
- The vertical migration pathway of the DNAPL has an insignificant width.
- The residual TCE saturation of the vertical DNAPL migration pathway (center of the DNAPL zone) is 30% (the maximum residual saturation suggested for the PGDP site by Dr. B. H. Kueper, 1991).
- DNAPL levels decline at a uniform percentage per unit distance from the source zones (similar to dispersion effects). Thus, for a DNAPL zone with a 30% saturation at the center and a 0.1 % saturation at the edge, the average DNAPL saturation in soil is 5.7% (Figure 2).

The calculation of volume of TCE DNAPL is the product of the volume of the TCE DNAPL source zone, the porosity, and the saturation, Table 3 documents the calculation of volume of DNAPL for the southeast C-400 block.

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Unit Factor = 0.751872

Unit Distance	DNAPL Saturation (%)
0	30.00
3	22.56
2	16.96
3	12.75
4	9.59
5	7.21
6	5.42
7	4.00
8	3.06
9	2.30
10	1.73
11	I.30
12	0.98
13	0.74
14	0.55
15	0.42
16	0.31
17	0.24
18	0.18
19	0.13
20	0.10

Avg. DNAPL Saturation: 5.74

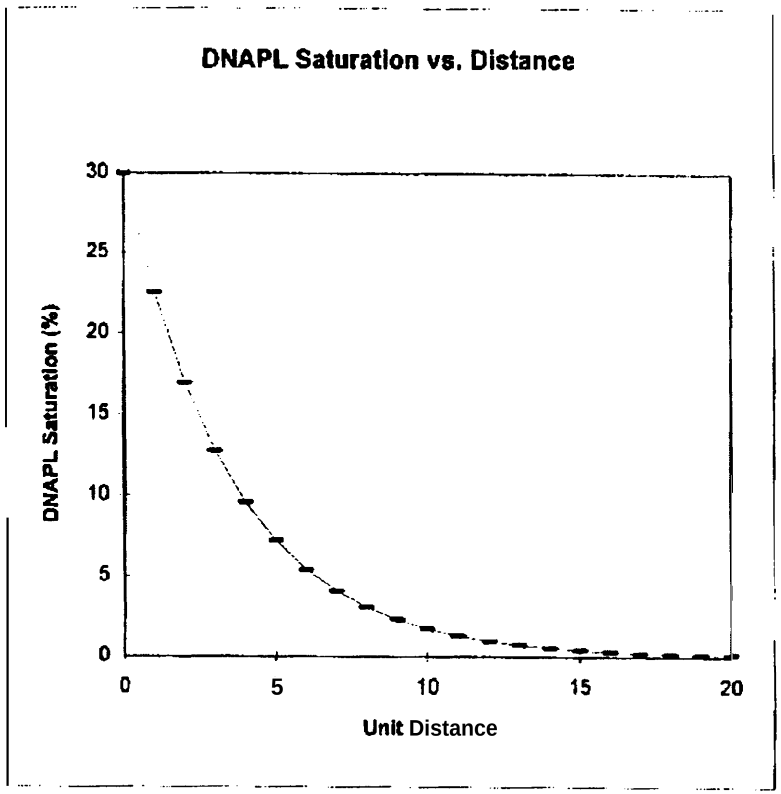

Figure 2. Average DNAPL Saturation of UCRS DNAPC Source Zone

Table 3. Calculation of TCE DNAPL for the Southeast C-400 Block

Depth Interval (ft)	Volume Represented (ft^3)	Assumed Porosity (%)	Assumed Saturation (%)	TCE DNAPL Volume (ft^3)
322 - 379	184,590	36	5.7	3,788

A volume of 3,788 ft^3 is equal to 28,338 gallons (107,259 liters).

South-End C-400 Building Storm Sewer and C-403 Neutralization Pit/SWMU 40 Source *Zones*

Soil characterization data are sufficient for the south-end C-400 Building storm sewer to determine that a DNAPL source zone exists at the point where the storm sewer exits from beneath the building. However, the data are inadequate to define the TCE DNAPL levels in three dimensions. The inference that a DNAPL source zone exists at the C-403 Neutralization Pit is based only on dissolved TCE levels, in the upper RGA and in the fill water that collected within the pit during the RI.

As previously discussed, the DNAPL source zone associated with the south-end storm sewer apparently extends to the RGA whereas the C-403 source zone is constrained within the UCRS, Borings 400-045 and 400-042 will be used to represent the geology of the UCRS for the south-end storm sewer and C-403 DNAPL source zones, respectively.

Table 4. Summary of UCRS Properties in the Southwest *C-400* Area and the North *C-400* Area

Depth Interval (ft)	Elevation *of* Base of Interval (ft)	Representative Lithology	Assumed Porosity (%)
Boring 400-045 (Southwest C-400 Area)			
0-16	360.5	silt to silty clay	36
16-47	*329.5*	silty sand and gravel?	36
47-52	324.5	silt and clay	36
Baring 400-042 (North C-400 Area)			
0-20	358.5	silt to silty clay	36
20-42	336.5	silty sand and gravel	36
		with sand and gravel	

It will be assumed that the UCRS DNAPL zone extends the full 52 ft depth of the UCRS soils in the southwest C-400 block but is limited to a depth of 42 ft beneath C-403.

The width of these TCE DNAPL zones remains largely undefined.

South-End Storm Sewer Source

Boring density is sufficient to determine that the width of the south-end sewer system DNAPL zone does not extend 100 ft from the source. If we assume that 100 µg/g (~0.1% saturation) of TCE in soil defines the DNAPL source zone, only one WAG 6 boring was completed in the source zone. The TCE levels (94 and 200 µg/g) suggest the boring, located approximately 30 ft south of the C-400 Building, is near the edge of the source zone.

Following calculations of the south-end storm sewer source will be based on the assumption that the DNAPL leak occurred at the edge of the building footprint and that the source zone is symmetrical, Thus, the south-end storm sewer source will be a cylinder with a 30 ft radius, centered on the south end of the C-400 Building where the storm sewer exits from beneath the building.

C-403 Source

WAG 6 borings around the perimeter of the C-403 Neutralization Pit did not return soil samples with TCE levels approaching 100 µg/g. As a default value, the following calculations of the C-403 source zone will be based on the assumption that the source zone (defined by TCE levels in soil greater than 100 µg/g) extends half the width of C-403. The C-403 Neutralization Pit measures 25 ft square in plan view. The C-403 Neutralization Pit source zone will be approximated as a cylinder centered below C-403, with a radius of 6.25 ft.

Table 5. Calculation of TCE DNAPL for the South-End Storm Sewer and C-403 Sources

Height (ft)	Radius (ft)	Volume Rcprtstnted (ft^3)	Assumed Porosity (%)	Assumed Saturation' (%)	TCE DNAPL Volume (ft^3)

The 3,017 ft^3 of DNAPL in the south-end storm sewer source is equal to 22,570 gallons (85,427 liters) and the 82 ft^3 of DNAPL in the C-403 source is equal to 793 gallons (3,002 liters).

DNAPL VOLUME CALCULATION IN THE RGA

The upgradient 100 mg/L (ppm) TCE isoconcentration contour appears to map the DNAPL source zones of the RGA. Moreover, the US Environmental Protection Agency recommends the use of 1% of the solubility of DNAPL (1% of the solubility of TCE is 110 mg/L) as an indication of DNAPL presence (EPA, 1992). Table 6 presents the assumptions used to define the area of the DNAPL source zones in the upper RGA (based on the TCE isoconcentration contour map for the elevation interval 310.0 - 314.9 ft).

Table 6. Upper RGA DNAPL Source Zone Assumptions

TCE DNAPL Source Zone	Areal Extent Assumption	Area (ft^2)
TCE Transfer Pump	cylinder with radius of 90 ft	25,447
TCE Leak Site (SWMU 11)	line source 200 ft long by 5 ft wide	1,000
South-End Storm Sewer	cylinder with radius of 25 ft	1,963

The geologist's logs and geophysical logs of WAG 6 borings 400-038 and 400-207 provide the most detailed description of soil properties for the south end of the C-400 Building. These borings will be used to represent the RGA DNAPL source zones. In both borings, an upper fine to medium grained sand horizon (base at elevation 323 ft in boring 400-038 and elevation 322 ft in boring 400-207) overlies a thick interval of coarse sand and gravel.

As previously discussed, the slice maps of dissolved-phase TCE levels suggest different depths of penetration for the DNAPL source zones. All three of the RGA source zones are represented in the slice map for the elevation range 310.0 - 314.9 ft. The influence of the south-end storm sewer diminishes rapidly with depth. For the approximation of the south-end storm sewer DNAPL zone, the base of the DNAPL zone will be assumed to be the base of the upper sand horizon at 322 ft.

The influence of the TCE Leak Site (SWMU 11) DNAPL source zone is evident down to an elevation of approximately 305 ft in the slice maps of dissolved-phase TCE levels. This depth closely corresponds to the depth (307 ft elevation) of an anomaly on the neutron porosity log of boring 400-207 and the depth (302 ft elevation) of an abrupt decline in field measurements of volatile organic compound levels (FID) in the soil core of boring 400-207. The base of the TCE Leak Site DNAPL zone will be assigned an elevation of 305 ft.

TCE isoconcentration contours indicate a DNAPL source zone extends to the base of the RGA near the location of the TCE transfer pump. Moreover, an increase in dissolved-phase TCE levels from boring 400-207 at the base of the RGA may signify the presence of a DNAPL pool at the base of the RGA. For the estimate of the DNAPL source zone below 305 ft elevation, the source zone will be assumed to approximate a cylinder measuring 25 ft in radius (based on the TCE isoconcentration contour map for the elevation interval 290.0 - 294.9 ft) and to extend to the base of the RGA, at an elevation of 286 ft.

Table 7. Calculation of the Volume of the RGA DNAPL Source Zones

TCE DNAPL Source Zone	Areal Dimensions (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)
TCE Transfer Pump (305-327 ft elevation)	radius = 90	25,447	22	559,834
TCE Transfer Pump (286-305 ft elevation)	radius = 25	1,963	19	37,297
TCE Leak Site/SWMU 11 (305-327 ft elevation)	length = 200 width = 5	1,000	22	22,000
South-End Storm Sewer (322-324.5 ft elevation)	radius = 25	1,963	2.5	4,908

The WAG 6 RI characterized soil properties around the C-400 Building. The mean of 26 measurements of porosity of RGA soils is 40%. An average TCE saturation level is required for the calculation of DNAPL volume. Unfortunately, no suitable samples for measurement of TCE levels in soil have been recovered from the coarse sand and gravel of the RGA.

The only available data related to DNAPL saturation in the RGA are the dissolved-phase levels of TCE. These limited measurements cannot be directly linked to a saturation level. However, the decline of dissolved-phase TCE levels with lateral distance from the center of the DNAPL source zone (with the exception of the direction of groundwater flow) may be a model of decrease of DNAPL saturation.

The following derivation of average DNAPL saturation for the source zone {upgradient area with dissolved-phase TCE levels greater than 100 mg/L) assume8 that the profile of dissolved-phase TCE levels in a direction normal to groundwater flow is a direct measure of the distribution of DNAPL saturation. Dispersion will also reduce dissolved-phase TCE levels away from the source zone. For this derivation, the effect of DNAPL distribution is assumed to be dominant.

This derivation is based on a conceptual model of a narrow pathway of vertical migration at the center of the DNAPL source zone. The coarse sand and gravel of the RGA is assumed to retain a DNAPL saturation of 20% (33% less than expected in the UCRS) in the core of the DNAPL source zone. As in the UCRS, DNAPL saturation in the RGA soils is assumed to decrease away from the center of the source zone by a uniform factor per unit distance.

The profile of dissolved-phase TCE levels for this derivation is taken east of the location of the former TCE transfer pump from the elevation slice 310.0 - 314.9 ft. Table 8 summarizes the relevant data from this transect.

Table 8. Distance to TCE Isoconcentration Contours Along Transect

Dissolved-Phase TCE Level (mg/L)	Lateral Distance From TCE Transfer Pump (ft)
1,100	0
100	60
10	120
1	160

Table 9 demonstrates the fit of the chosen unit factor (multiplier to derive the decline in dissolved-phase TCE levels for unit distance) for the transect. The unit distance arbitrarily has been selected as 10 ft.

Table 9. Fit of Unit Factor (0.67) to Transect Data

Lateral Distance From TCE Transfer Pump (ft)	Derived Dissolved-Phase TCE Level (mg/L)	Transect Dissolved-Phase TCE Level (mg/L)
0	1,100.0	1,100
10	737.0	
20	493.8	
30	330.8	
40	221.7	
50	148.5	
60	99.5	100
70	66.7	
80	44.7	
90	29.9	
100	20.1	
110	13.4	
120	9.0	10
130	6.0	
140	4.0	
150	2.7	
160	1.8	1

By assuming the decline in TCE concentration is directly related to decrease in DNAPL saturation and that the residual DNAPL saturation of the center of the source zone is 20%, the derived unit factor is a multiplier to calculate DNAPL saturation in the source zone along the transect. Table 10 presents the calculated saturation levels.

Table 10. Derived DNAPL Saturation of the Source Zone

Lateral Distance From TCE Transfer Pump (ft)	Derived DNAPL Saturation (%)
0	20.0
10	13.4
20	9.0
30	6.0
40	4.0
50	2.7
60	1.8
Average DNAPL Saturation	**8.1**

By applying this derived average saturation to all RGA DNAPL zones, Table 11 presents the calculation of DNAPL volume in the RGA.

Table 11. Calculation of the Volume of DNAPL in the RGA Source Zones

TCE DNAPL Source Zone	Volume (ft^3)	Assumed Porosity (%)	Assumed Saturation (%)	TCE DNAPL Volume (ft^3)
TCE Transfer Pump (305-327 ft elevation)	559,834	40	8.1	18,139
TCE Transfer Pump (286-305 ft elevation)	37,297	40	8.1	1,208
TCE Leak Site (SWMU 11) (305-327 ft elevation)	22,000	40	8.1	713
South-End Storm Sewer (322-324.5 ft elevation)	4,908	40	8.1	159

Table 12. Volume of DNAPL in the RGA Source Zones

TCE DNAPL Source Zone	TCE DNAPL Volume (ft^3)	TCE DNAPL Volume (gallons)	TCE DNAPL Volume (liters)
TCE Transfer Pump (305-327 ft elevation)	18,139	135,698	513,696
TCE Transfer Pump (286-305 ft elevation	1,208	9,037	34,210
TCE Leak Site (SWMU 11) (305-327 ft elevation)	713	5,334	20,189
South-End Storm Sewer (322-324.5 ft elevation)	159	1,189	4,503

NOTES ON CALCULATION OF DNAPL VOLUMES

The above calculations ignore the presence of pooled DNAPL. Where pooled DNAPL occurs, the DNAPL volume will be significantly greater than the derived volumes. Dissolved-phase TCE levels in WAG 6 boring 400-207 increase at the base of the RGA, suggesting a DNAPL pool may be present at the base of the RGA. The WAG 6 data are insufficient to quantify the dimensions or volume of pooled DNAPL,

DNAPL pools tend to develop at the interface of permeability barriers. The base of the sand and gravel horizon in the UCRS is another horizon where significant DNAPL pools should be expected.

^{99}TECHNETIUM SOURCE ZONE CALCULATION IN THE UCRS

Technetium Storage Tank/SWMU 47 Source Zone

The lithologic log of the soil boring for well MW175 will be used to represent the soil textures of the Technetium Storage Tank source zone. Table 13 summarizes the dominant UCRS textures with depth.

Table 13. Summary of UCRS Soil Textures for the Former Location of the Technetium Storage Tank

Depth Interval (ft)	Elevation of Base of Interval (ft)	Representative Lithology
0-20	358	clay
20-30	348	gravely sand
30-32	346	sandy clay
32-39	339	gravely sand
39-49	329	clay and sandy salt

505120

The WAG 6 RI found the UCRS soils were unsaturated in the vicinity of the Technetium Storage Tank location down to an elevation of approximately 335 ft. Because ^{99}Tc has a high solubility in oxidized waters (approximately 4,300 pCi/L), this calculation assumes that the only *soils* retaining ^{99}Tc are in the unsaturated zone, Thus, the base of the ^{99}Tc source zone is at an elevation of 335 ft, a depth of 43 *ft.*

All of the seven surface soil samples collected within and adjacent to the bermed area that marks the former location of the Technetium Storage Tank exhibit high ^{99}Tc activity. The surface *soil* ^{99}Tc activity ranges from 4.5 to 53 pCi/g. The only subsurface soil ^{99}Tc activity data comes from analysis of samples from boring 047-002. Table *14* presents the ^{99}Tc analyses for subsurface soil samples of 047-002.

Table 14. ^{99}Technetium in Subsurface Soil Analyses for Boring 047-002

Depth Interval (ft)	^{99}Technetium Activity (pCi/g)
1.0-4.5	8.1
8.5-12.0	*0.5*
15.5-19	2.2
26-29.5	0.4
Average ^{99}Technetium Activity	2.8

The average ^{99}Tc activity of soils from boring 047-002 will be used as the measure of ^{99}Tc activity of the source zone soils.

The three-dimensional distribution of data is insufficient to define the limits of the Technetium Storage Tank source zone. As a default value, the area enclosed *by* the berm will be used to define the lateral dimensions of the source zone. The basis for this assumption is that spills or leaks from the storage tank are not expected *to* spread beyond the berm at the land surface and groundwater flow (the likely mechanism for ^{99}Tc migration) is predominately vertical in the UCRS.

The bermed area has a surface area of approximately *625* ft^2. Thus, approximately 26,875 ft^3 of soil is contained within the ^{99}Tc source area. At an average ^{99}Tc activity of 2.8 pCi/g and a bulk density of approximately 1.70 g/cm^3 (specific gravity of 2.65 g/cm^3 and porosity of 36%), the total ^{99}Tc activity of the source zone is:

$$26{,}875\ ft^3 \times 28{,}317\ cm^3/ft^3 \times 1.70\ g/cm^3 \times 2.8\ pCi/g = 3.62 \times 10^9\ pCi$$

C-403 Neutralization Pit/SWMU 40 Source Zone

The lithologic logs of the soil boring for well MW178 and boring 040-008 represent the soil textures of the C-403 Neutralization Pit source area. Table 15 presents a summary of the area geology.

Table 15. Summary of UCRS Textures for the Area of the C-403 Neutralization Pit

Depth Interval (ft)	Elevation of Base of Interval (ft)	Representative Lithology
0-17	359	fill (clayey gravel)
17-24	352	clayey silt
24-30	330	gravely sand
38-52	324	clayey silt

One soil boring sampling the backfill of the C-403 Neutralization Pit found water at shallow depth. However, nearby piezometers document the depth of the UCRS saturated zone to be much deeper, at an elevation of approximately 341 ft. Apparently, the depth to water in the saturated backfill of the C-403 pit represents a localized perched water table. For the purposes of approximating a ^{99}Tc source zone, the source zone will be assumed to extend between the base of the C-403 Neutralization Pit (elevation 351 ft) and an elevation of 341 ft.

The only ^{99}Tc in soil analyses for the source zone depths at SWMU 40 are for single samples taken from the east and west sides of the C-403 pit. In both samples, the ^{99}Tc activity was minimal (0.1 and 0.4 pCi/g). For the purposes of defining a source zone volume for the C-403 Neutralization Pit, it will be assumed that the source zone approximates a cylinder with a diameter extending one half of the width of the pit (the pit is 25 ft wide).

For lack of better data, it will also be assumed that the average ^{99}Tc activity in soil and the bulk density of the soil is the same as the average for the Technetium Storage Tank area, 2.8 pCi/g and 1.70 g/cm^3, respectively. The total ^{99}Tc activity of the source zone is:

$$1{,}227\ ft^3 \times 28{,}317\ cm^3/ft^3 \times 1.70\ g/cm^3 \times 2.8\ pCi/g = 1.65 \times 10'\ pCi$$

MASS OF ^{99}TECHNETIUM IN THE UCRS SOURCE ZONES

Table 16 summarizes the volume and total activity of the two discrete UCRS ^{99}Tc source zones as well as the mass of ^{99}Tc present, assuming a specific activity of 0.017 Ci/g (Shleien, 1992).

Table 16. Summary of UCRS ^{99}Technetium Source Zones

^{99}Tc Source Zone	^{99}Tc Source Zone Volume (ft^3)	Total ^{99}Tc Activity in ^{99}Tc Source Zone (Ci)	Total ^{99}Tc Mass in ^{99}Tc Source Zone (g)
Technetium Storage Tank (SWMU 47)	26,875	3.62×10^{-3}	2.13×10^{-1}
C-403 Neutralization Pit (SWMU 40)	1,227	1.65×10^{-4}	9.71×10^{-3}

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EPA, 1992. *Estimating Potential for Occurrence of DNAPL at Superfund Sites*, Publication 9355.4-07FS, United States Environmental Protection Agency, R.S. Kerr Environmental Research Laboratory, January, 1992.

Kueper, B.H., 1991. *The Occurrence of Dense, Non-Aqueous Phase Liquids in the Subsurface at the Paducah Gaseous Diffusion Plant*, KY/ER/Sub/0815-1015/91/2, Queens University, Kingston, Canada, November, 1991.

Shleien, 1992. Shleien, Bernard, ed., *The Health Physics and Radiological Health Handbook*, Scinta, Inc., Silver Springs, MD, 1992.

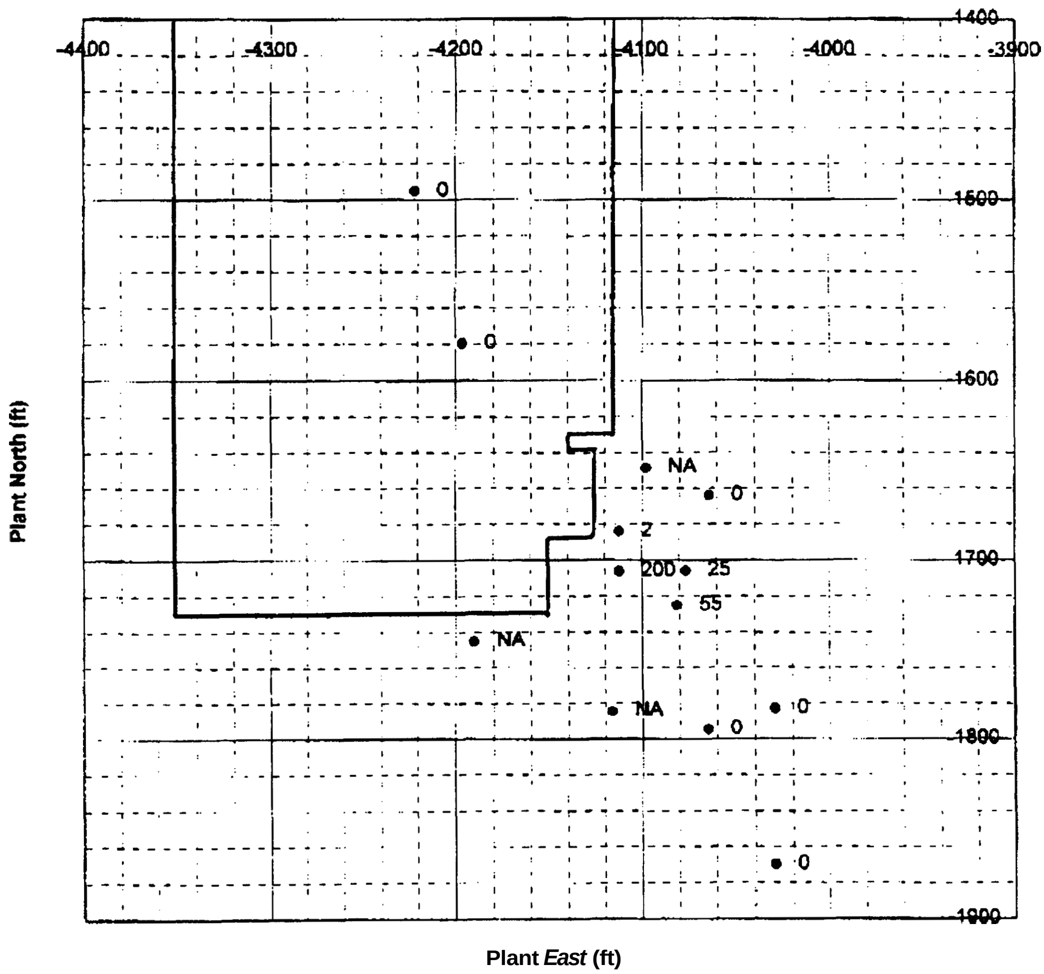
Appendix A
Isocancentration Maps of TCE in Soil (µg/g *or ppm*)
for *the* Southeast C-400 Block

- soil sample

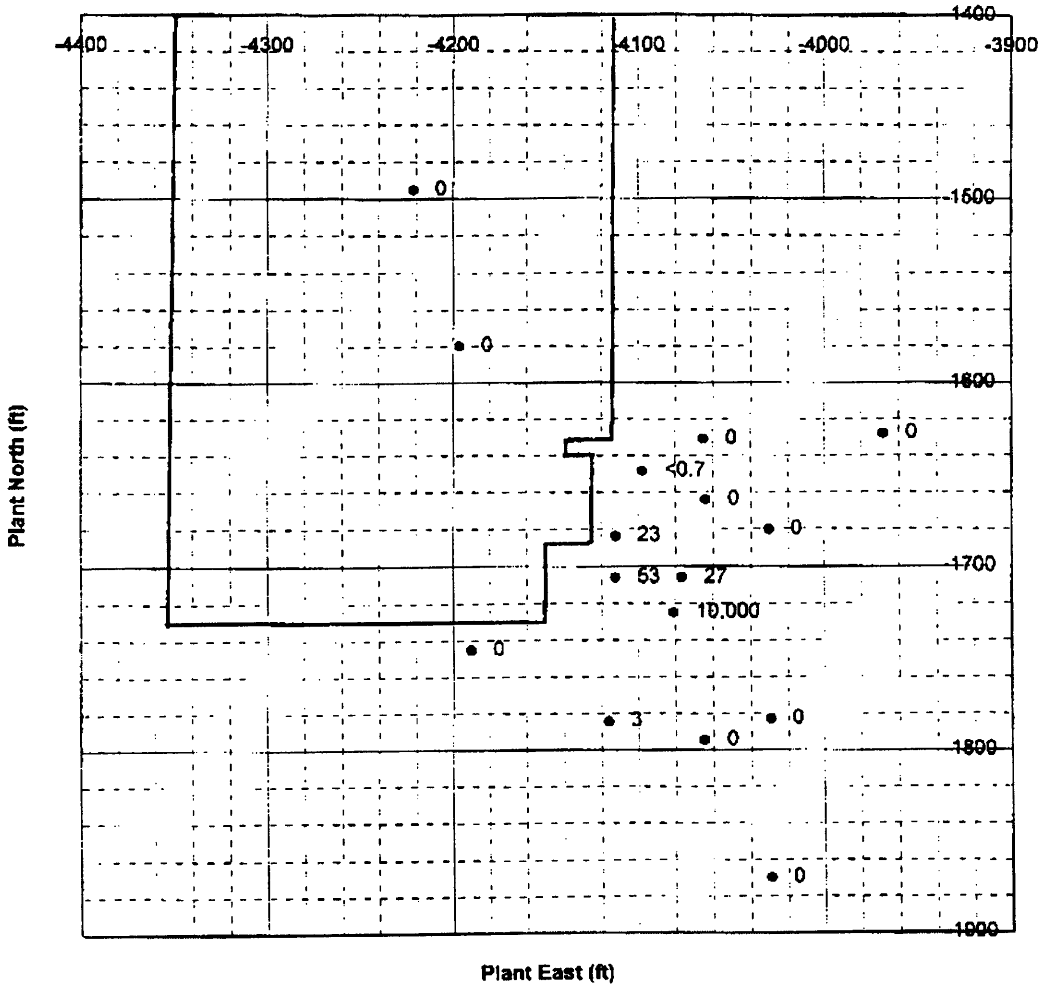
Ж water sample

505124

TCE LEVEL (375.0 - 379.9)

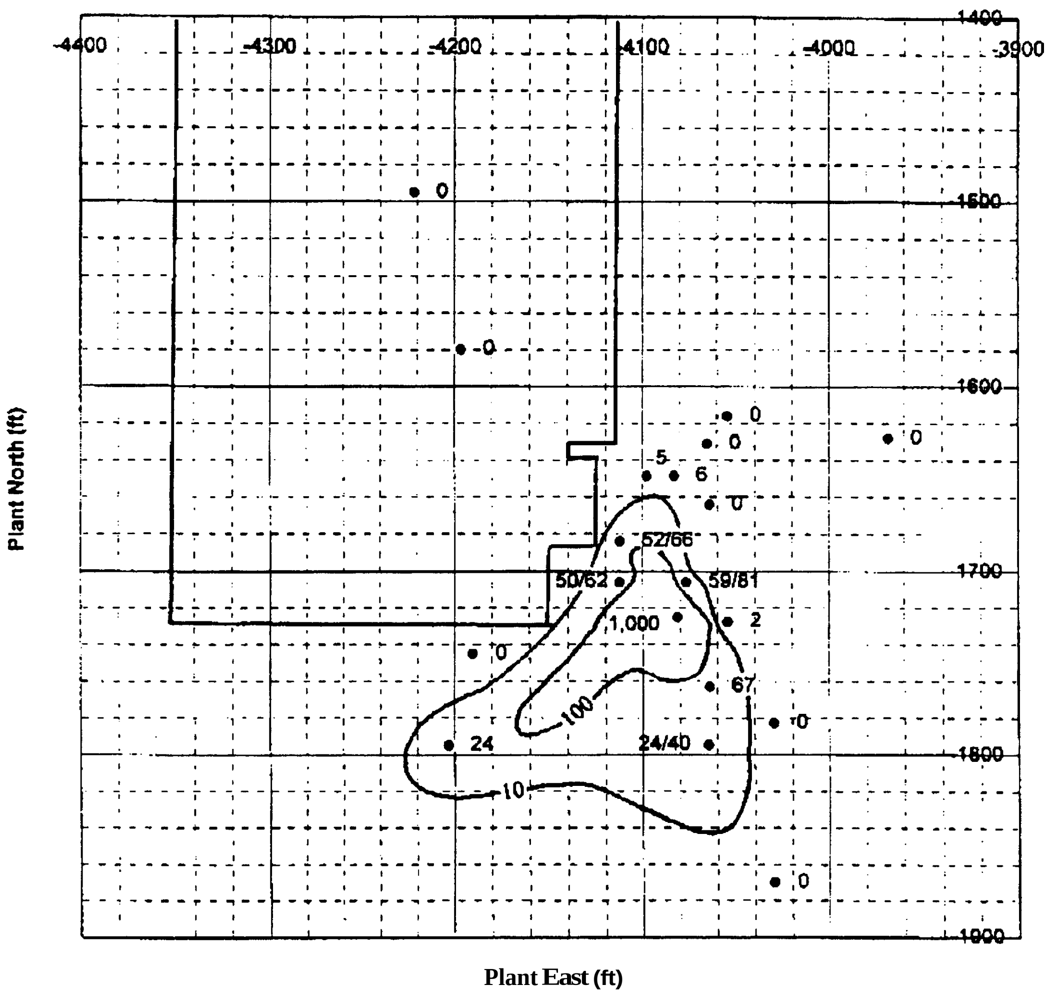


TCE LEVEL *(370.0 - 374.9)*



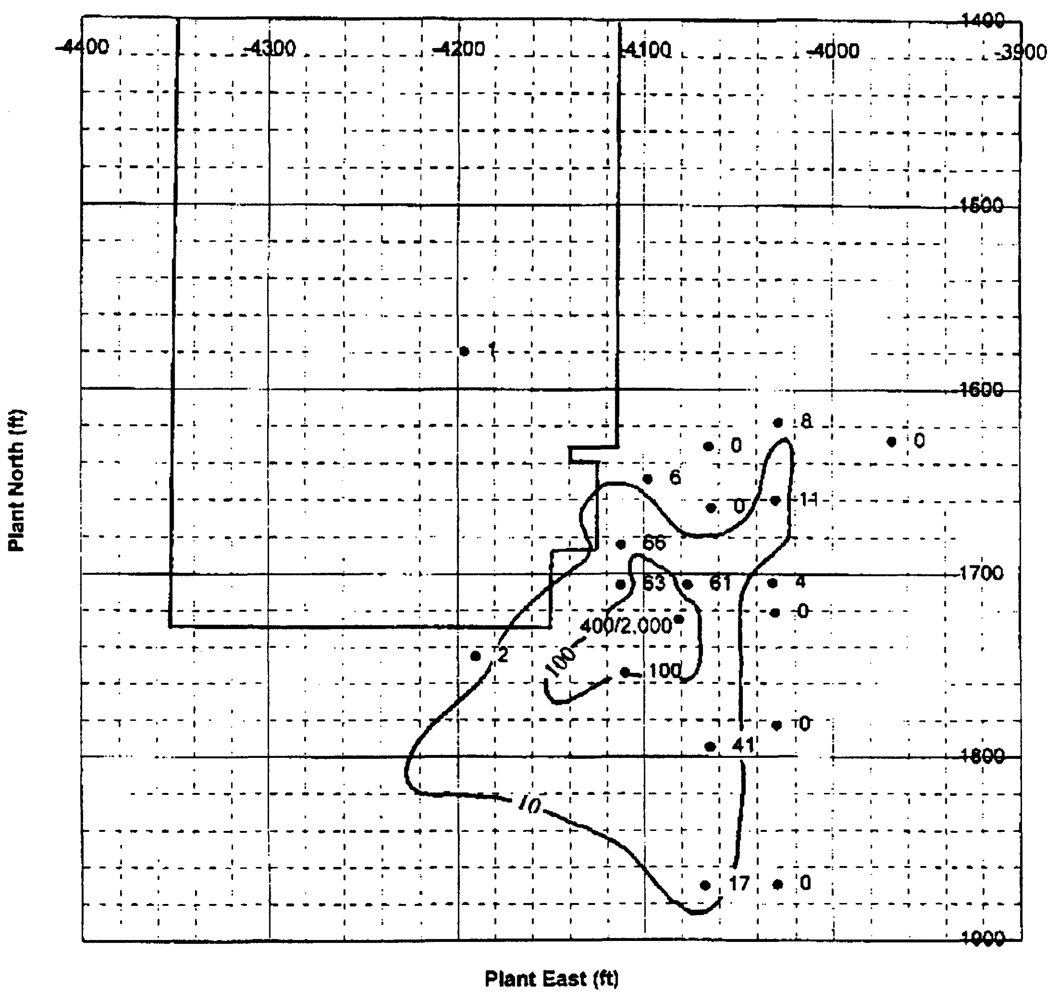
505126

TCE LEVEL (365.0 - 369.9)



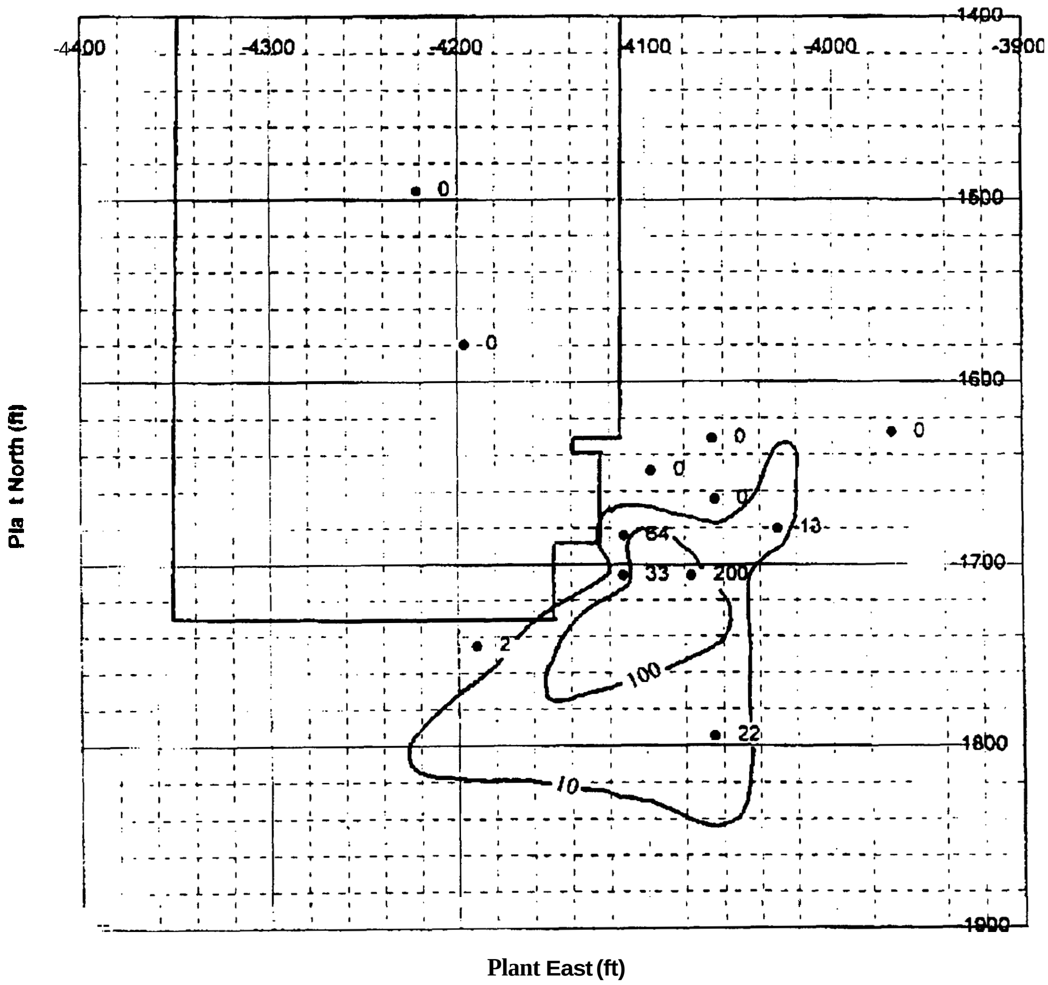
505127

PCE LEVEL (360.0 - 364.9)



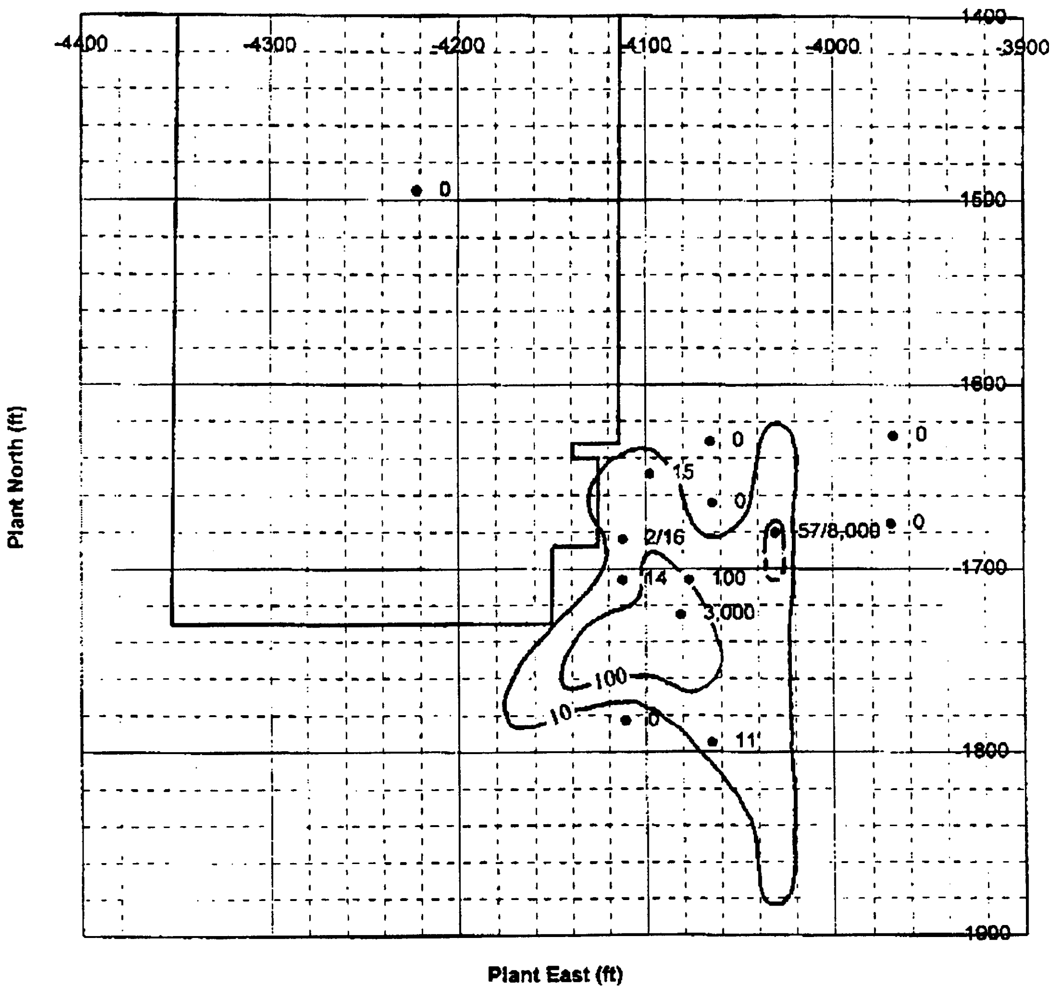
505128

TCE LEVEL (355.0 - 359.9)



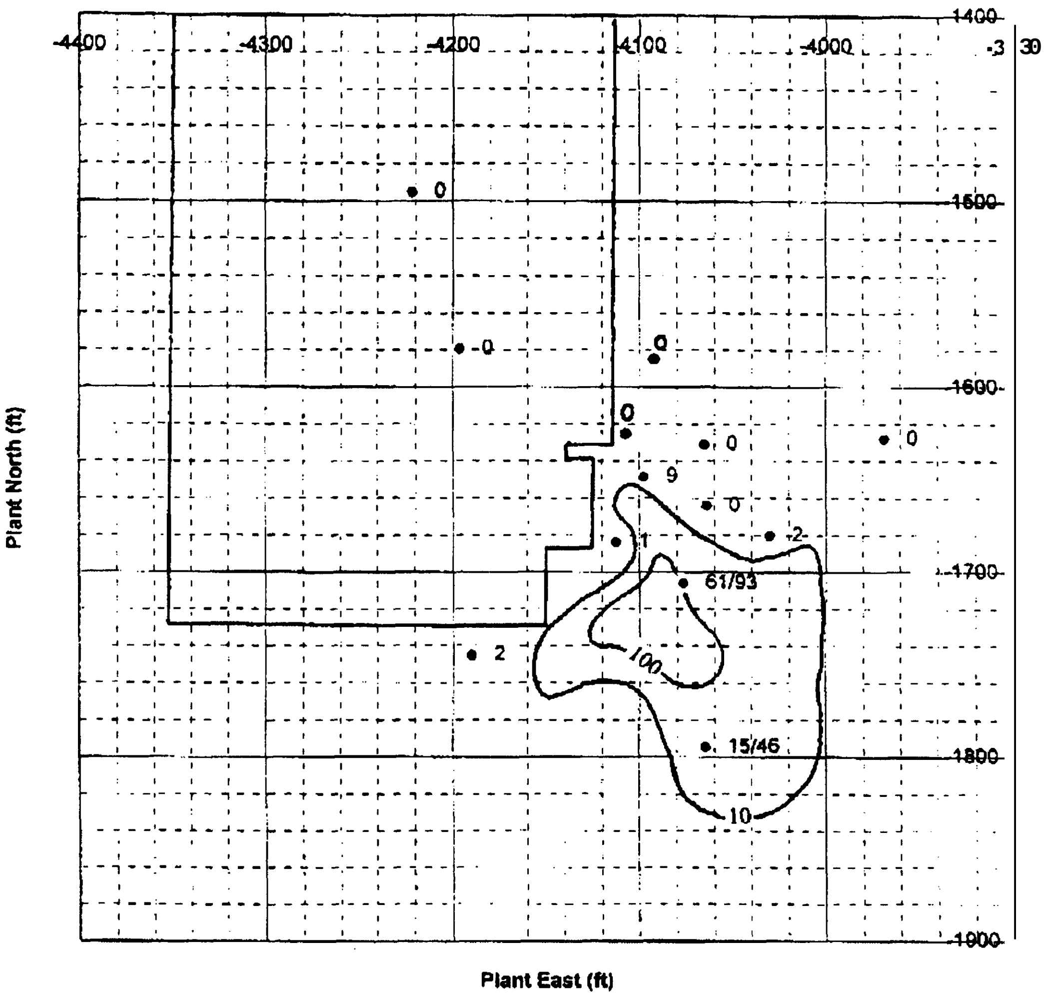
505129

TCE LEVEL. (350.0 - 354.9)



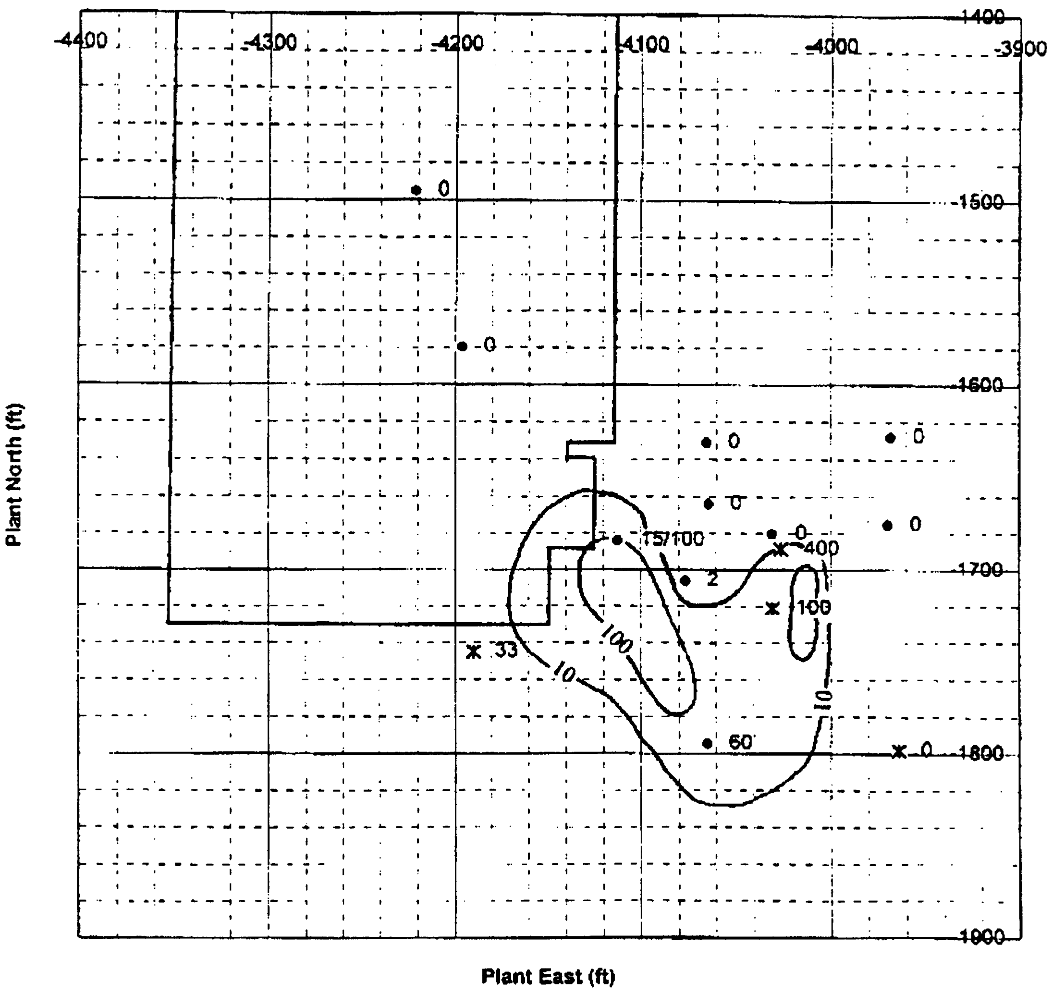
505130

TCE LEVEL (345.0 - 349.9)



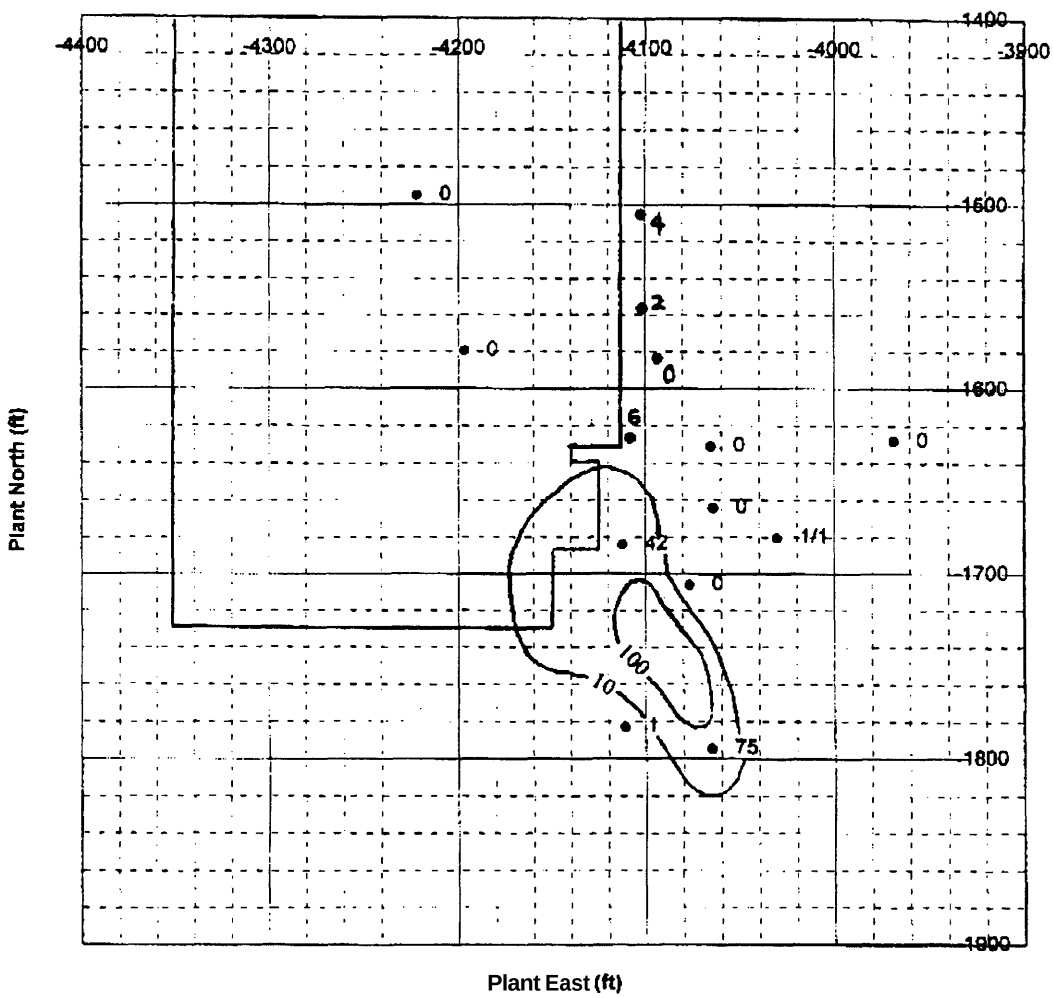
505131

TCE LEVEL *(340.0 - 344.9)*



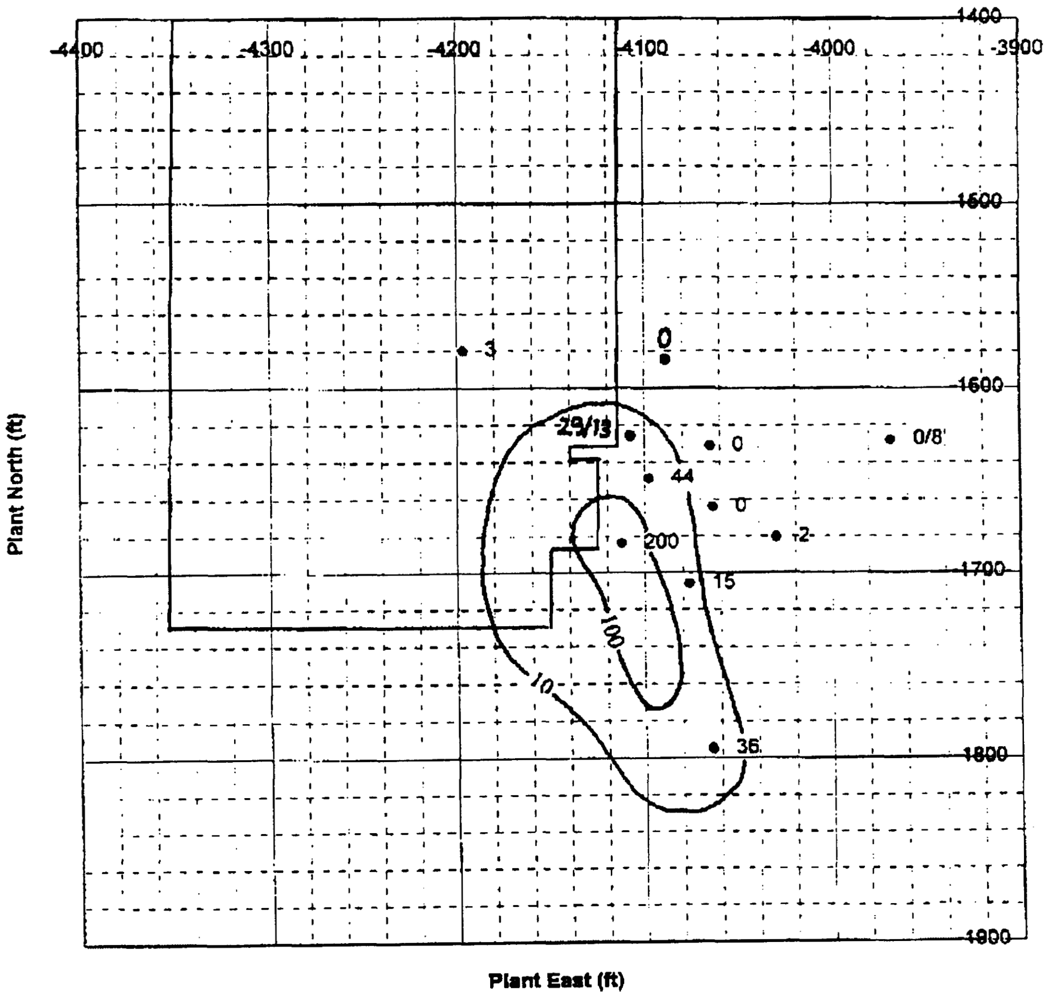
505132

TCE LEVEL (335.0 - 339.9)



505133

TCE LEVEL *(330.0* - 334.9)

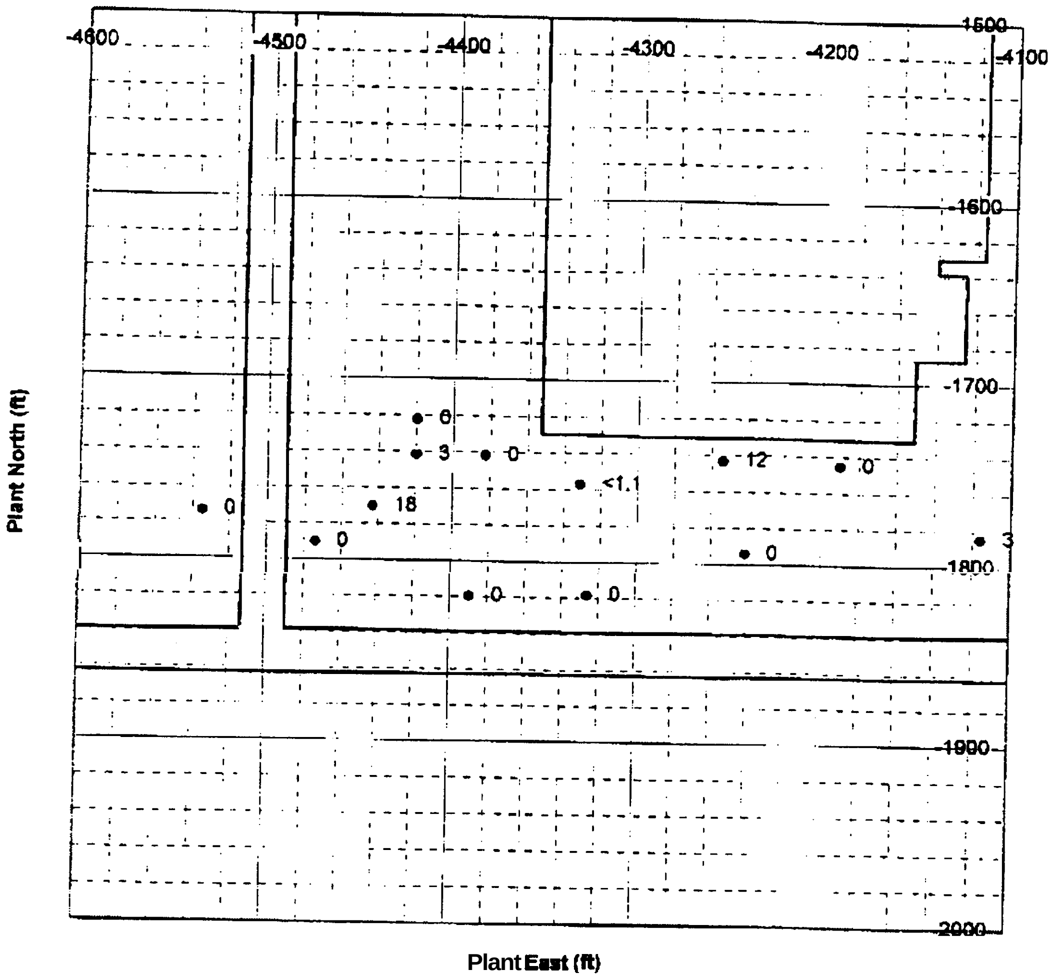


505134

Appendix B
TCE in Soil Analyses (μg/g or ppm) for the Area of the C-400 Building Southwest Storm Sewer

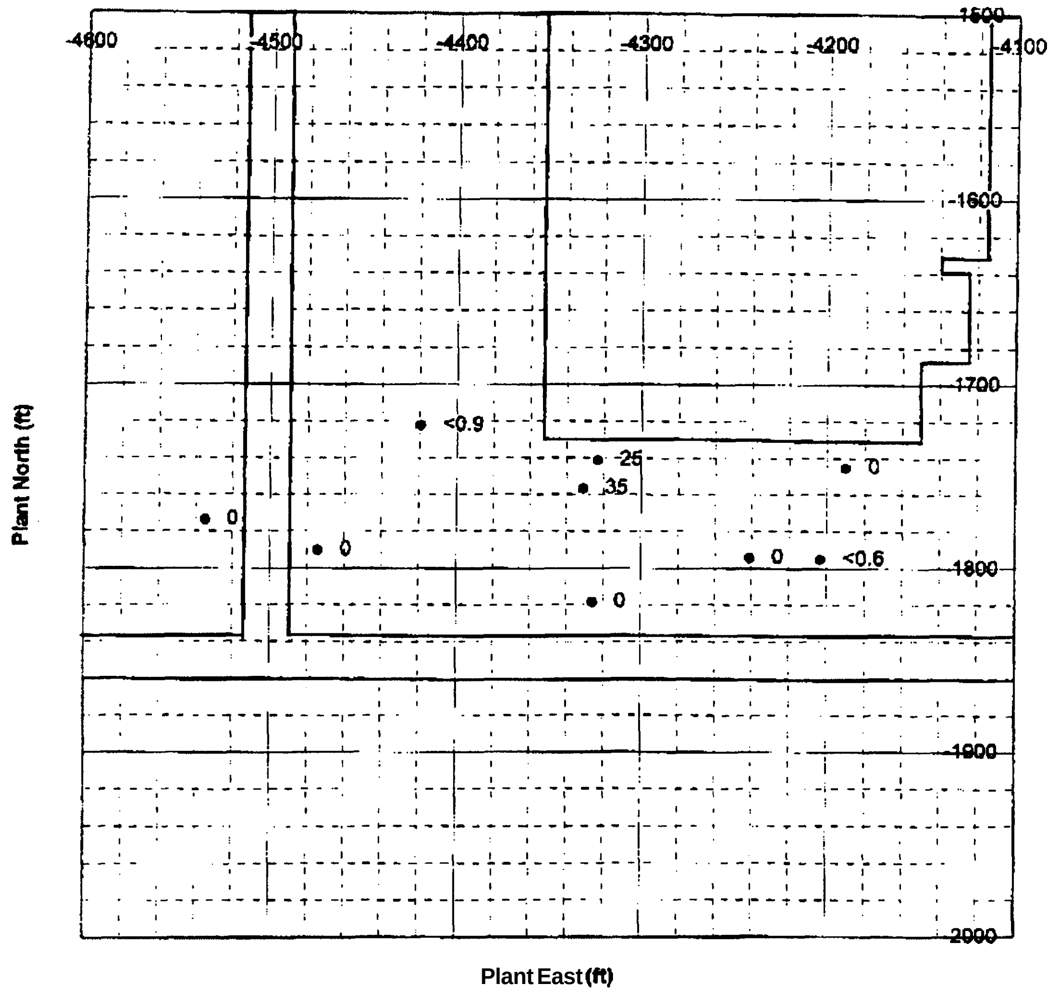
505135

TCE LEVEL (370.0 - 374.9)



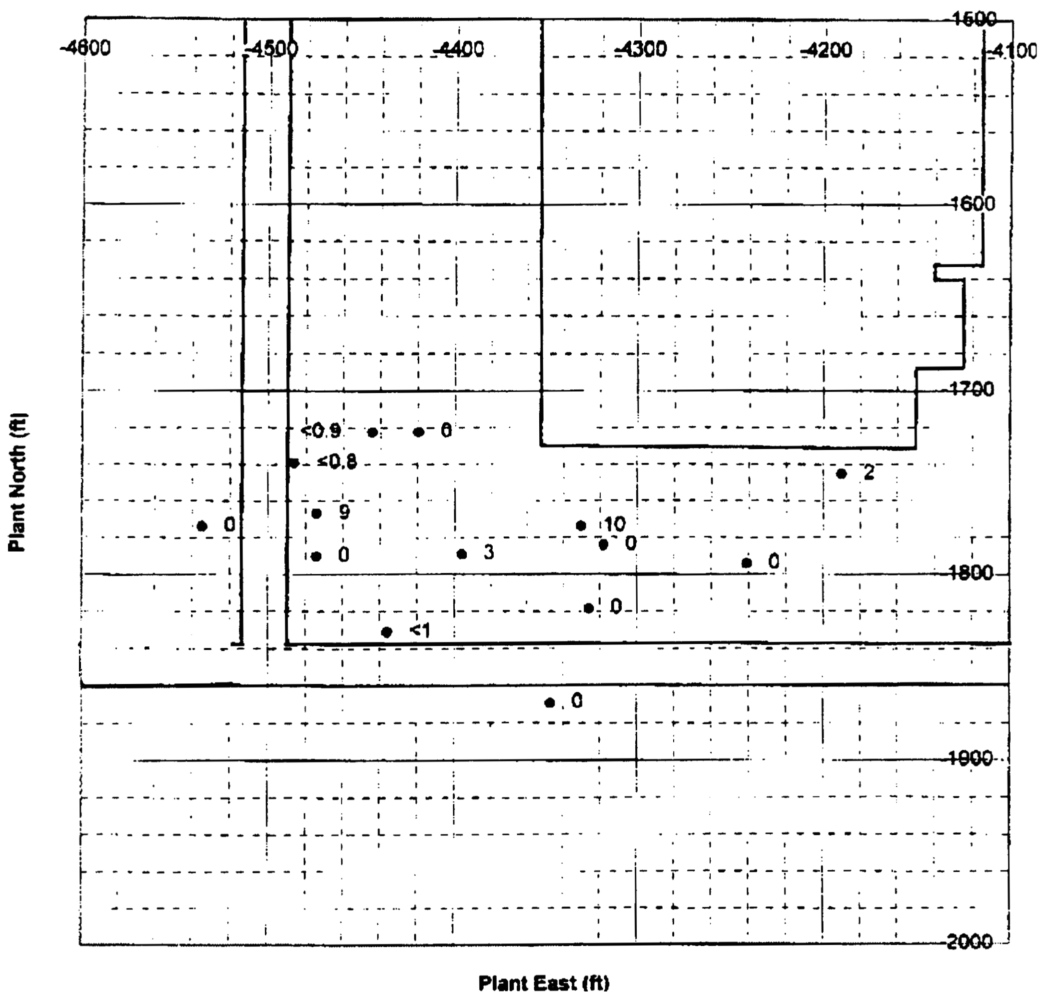
505136

TCE LEVEL (365.0 - 369.9)



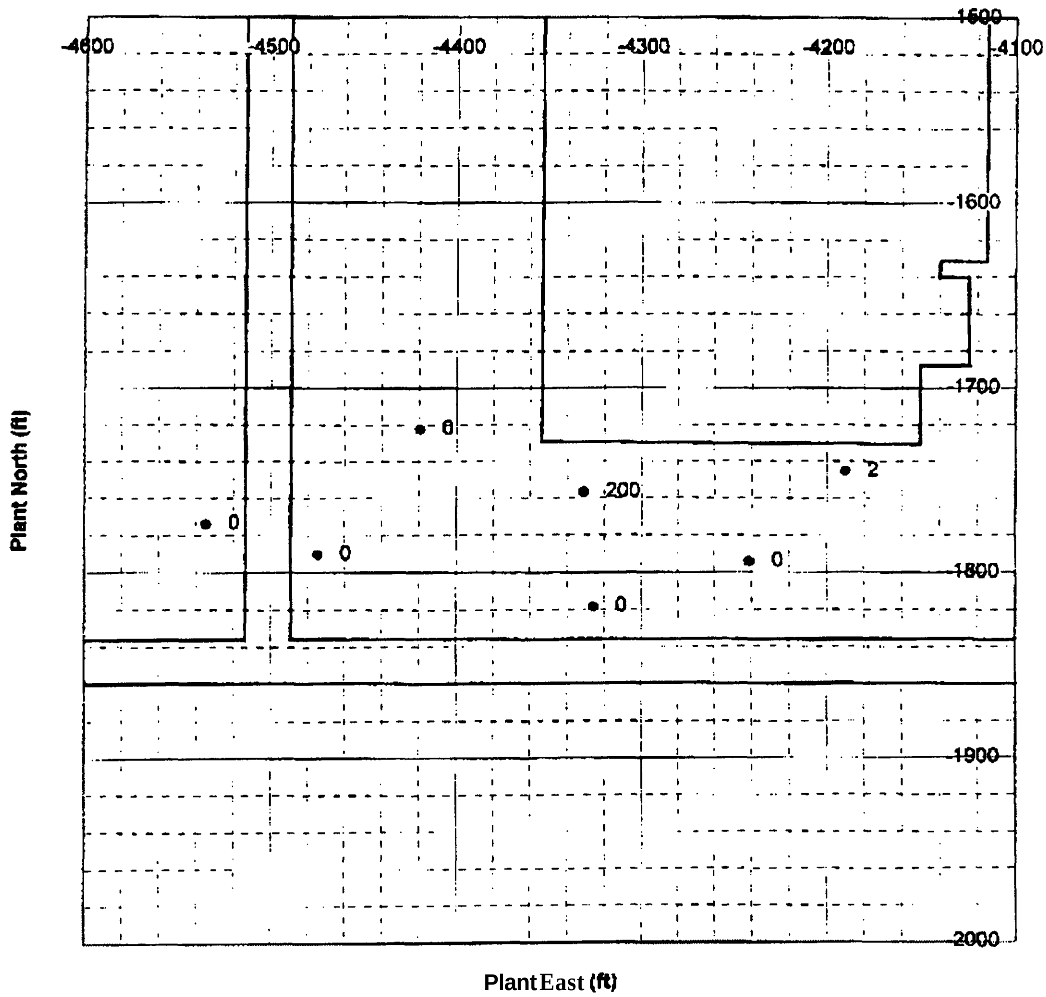
505137

TCE LEVEL (360.0 - 364.9)



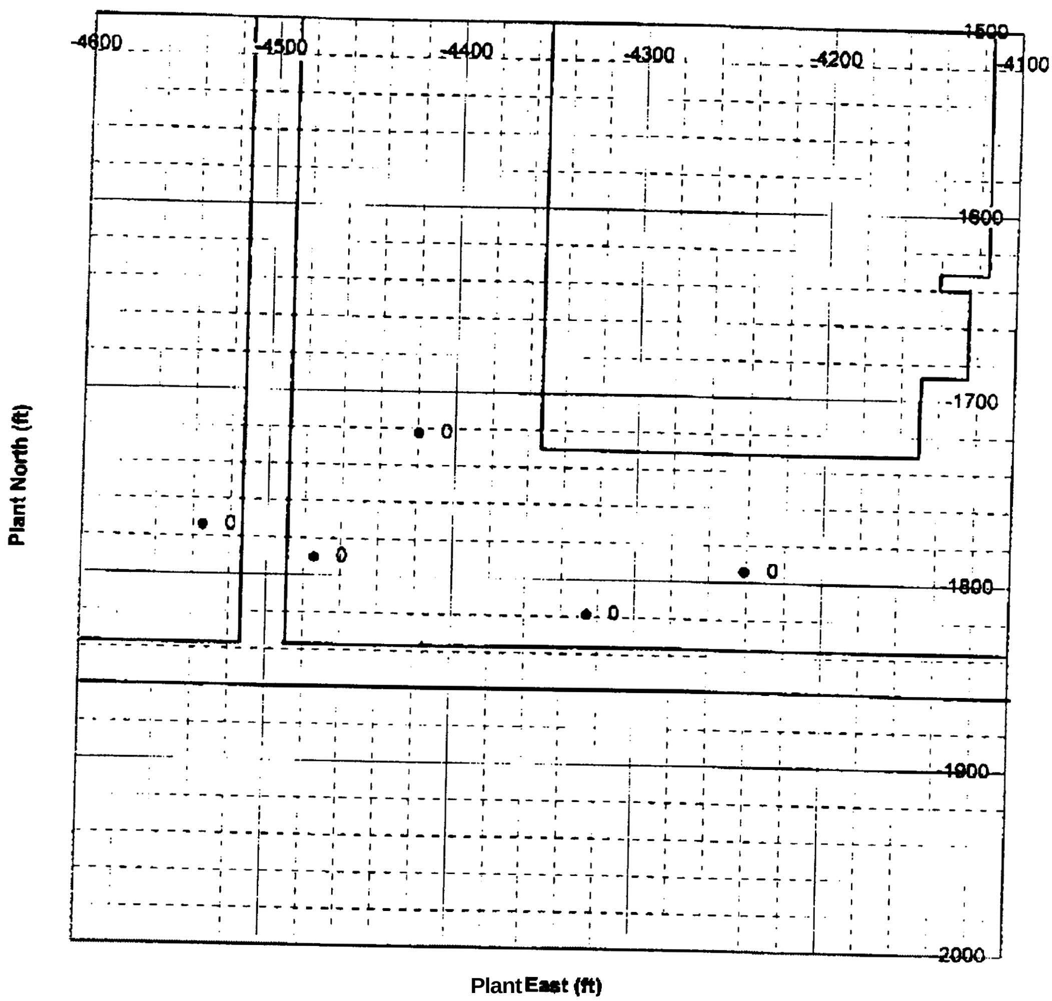
505138

TCE LEVEL (355.0 - 369.9)



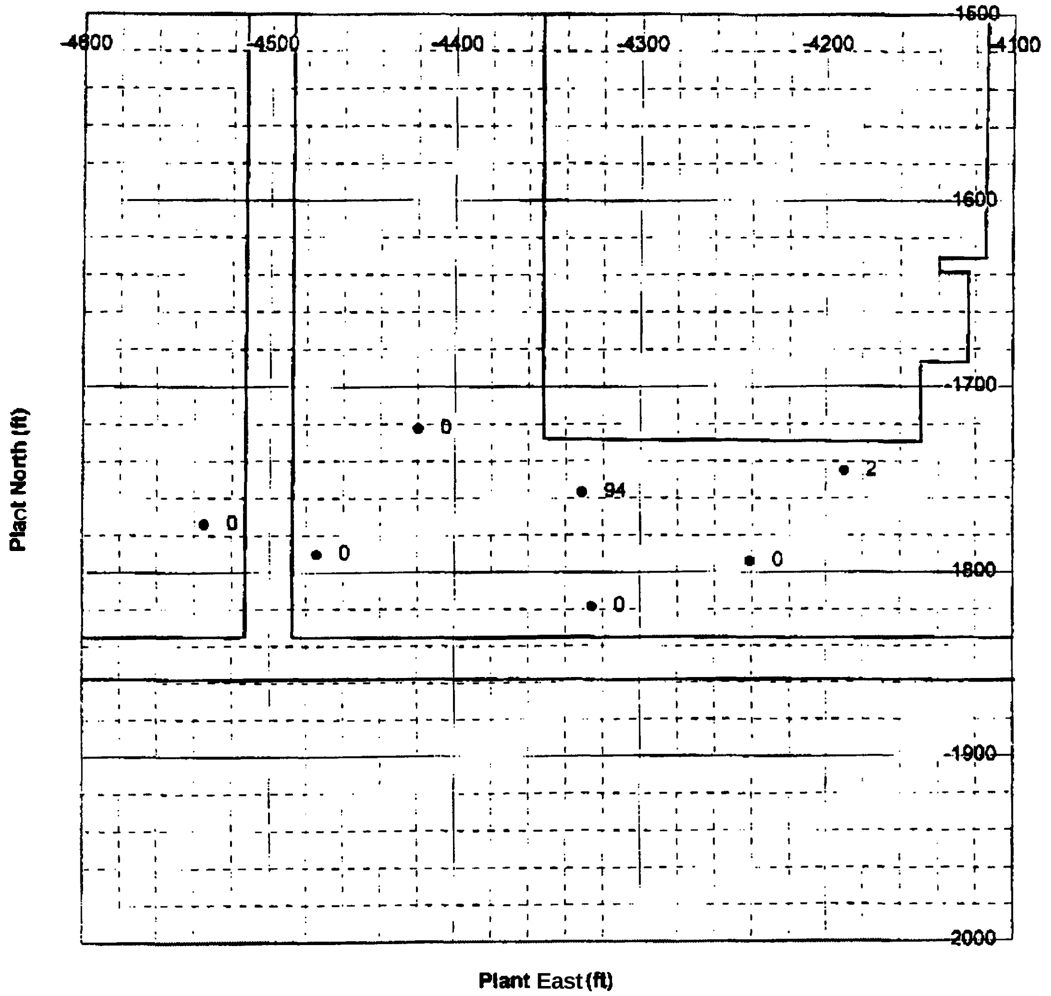
505139

TCE LEVEL (350.0 - 354.9)



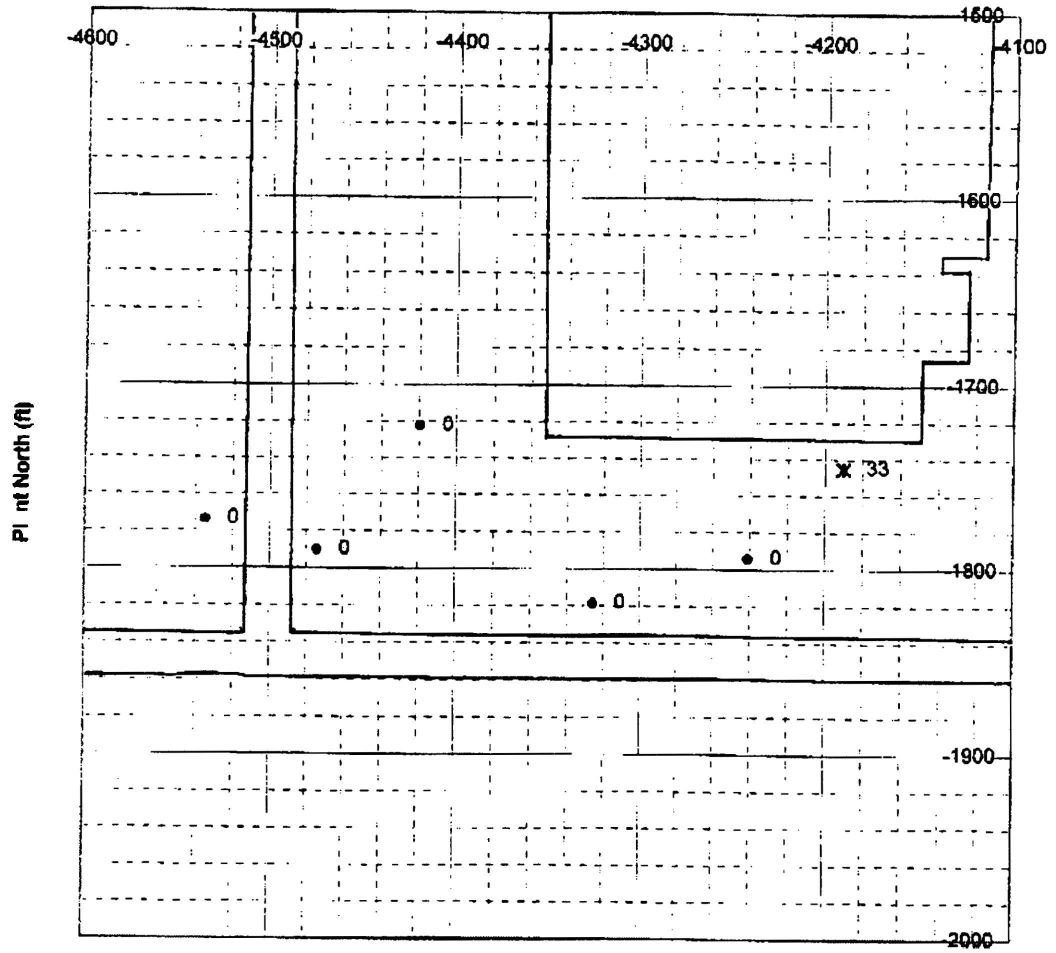
505140

TCE LEVEL (345.0 - 349.9)



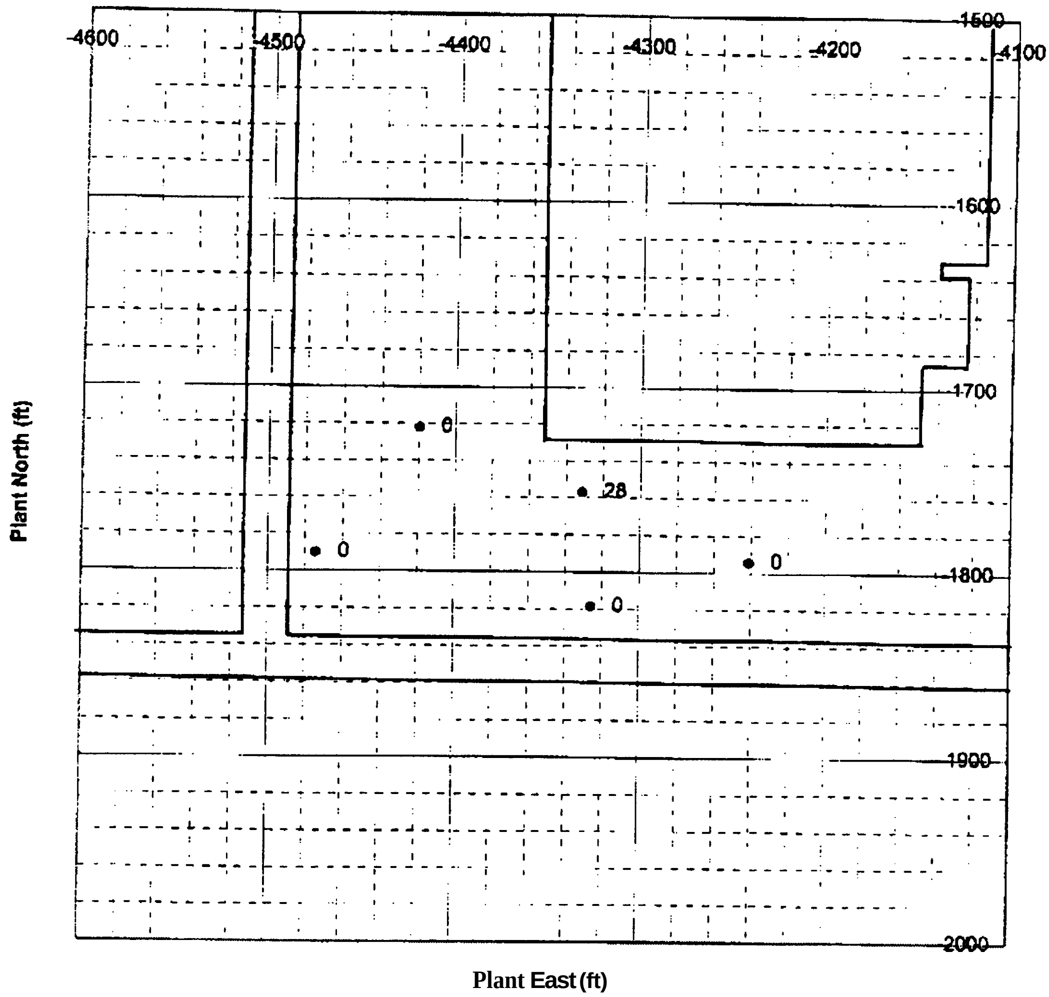
505141

TCE LEVEL (340.0 - 344.9)



505142

TCE LEVEL (335.0 - 339.9)



505143

Appendix C
Contoured Isoconcentration Maps of Dissolved-Phase TCE (μg/L or *ppb*)
and
Contoured Isoactivity Maps of Dissolved Beta Activity (pCi/L) for the RGA

Ж water sample

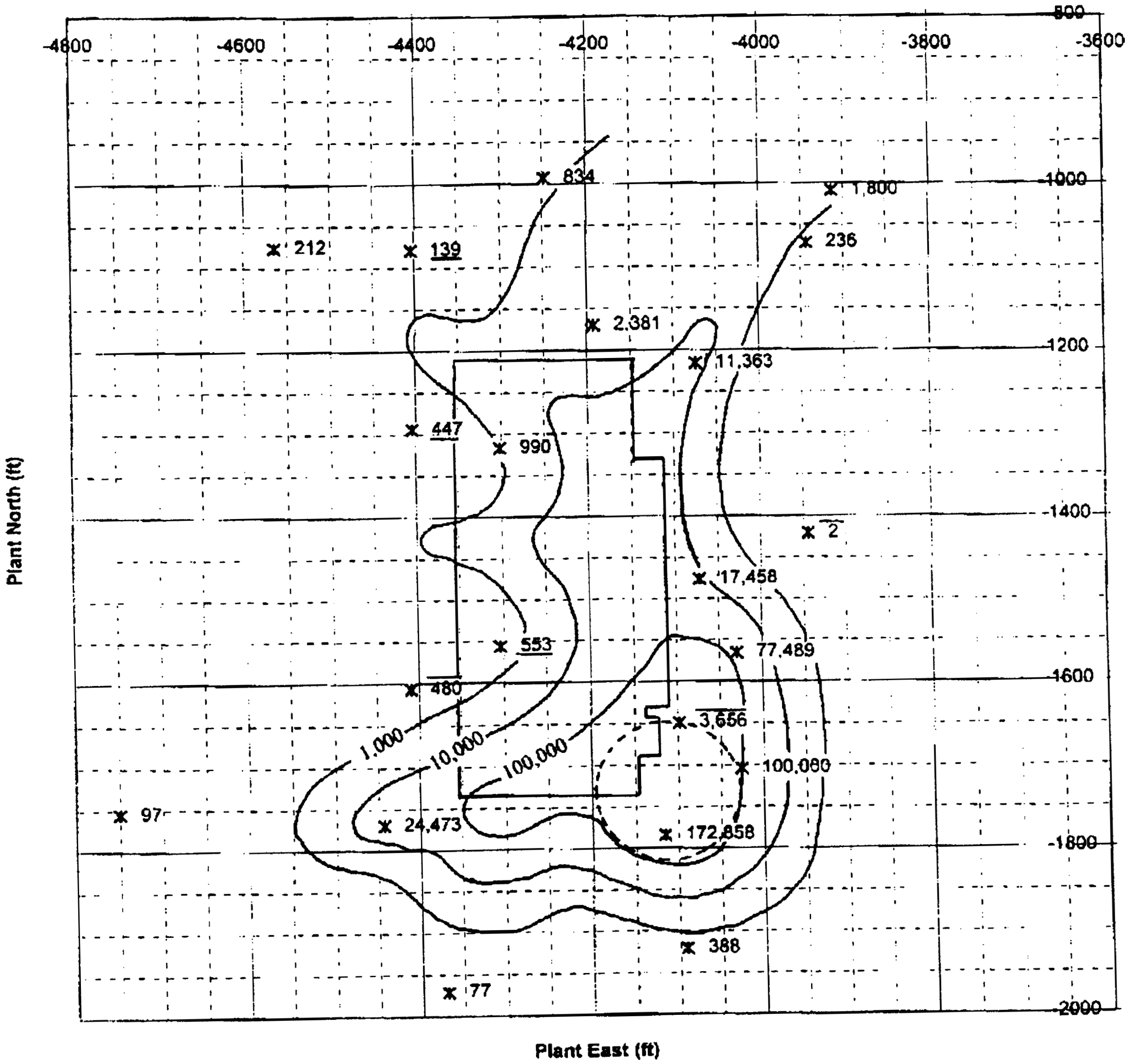
$\overline{\#}$ value is biased low by sampling or analytical methods

$\underline{\#}$ value is biased high by sampling or anlytical methods

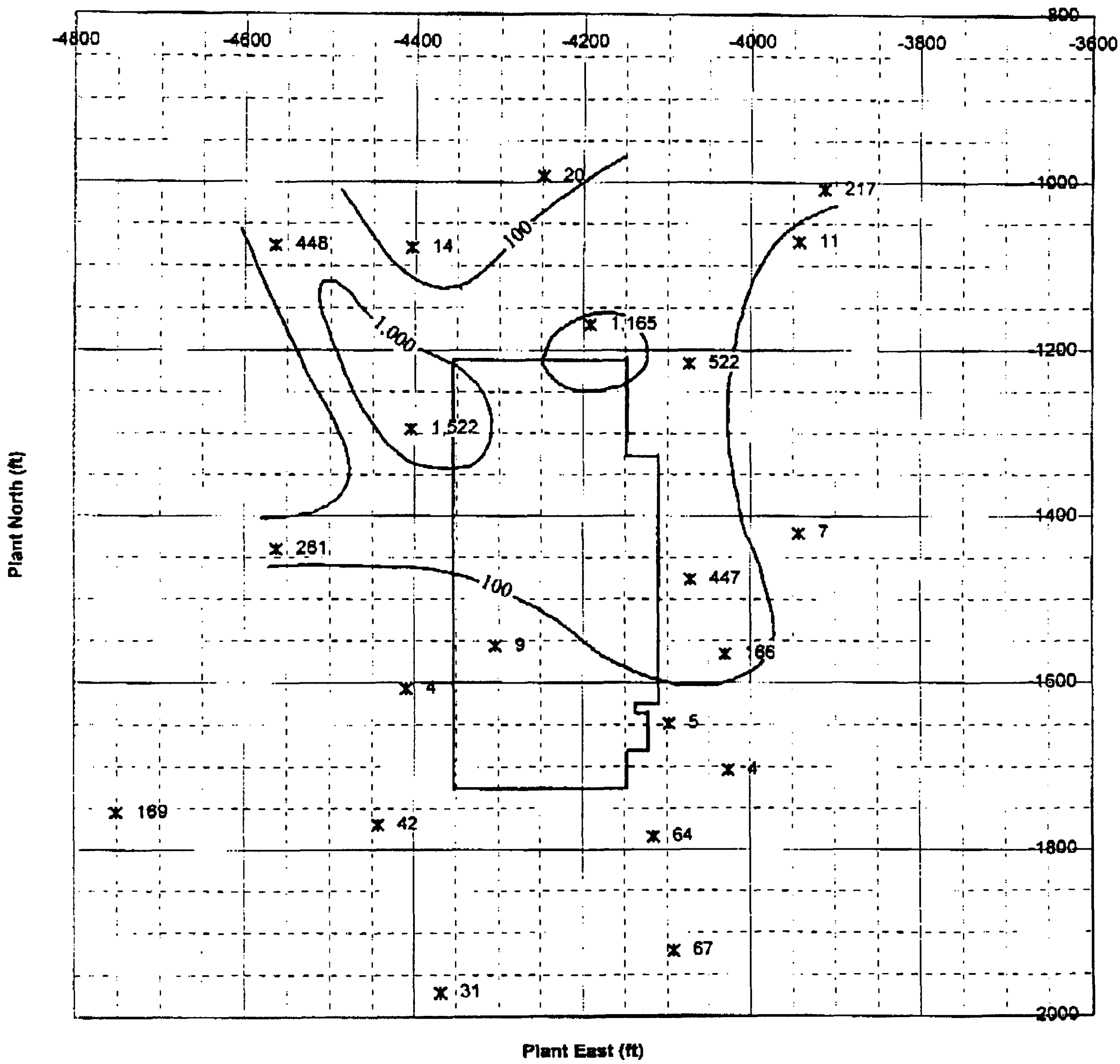
DNAPL source *zone* associated with the TCE transfer pump leak site

505144

TCE LEVEL (310.0 - 314.9)

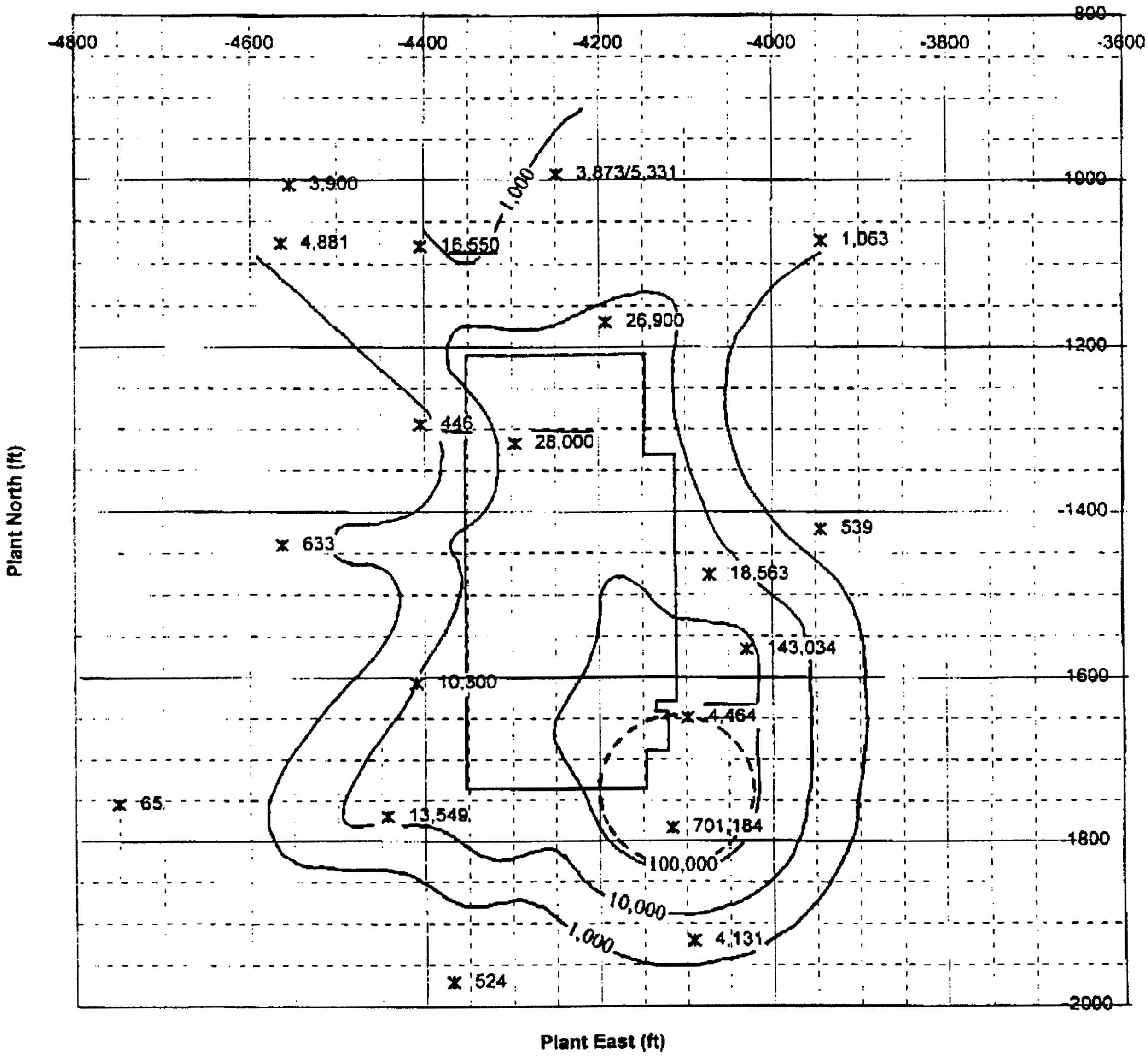


BETA ACTIVITY (310.0 - 314.9)



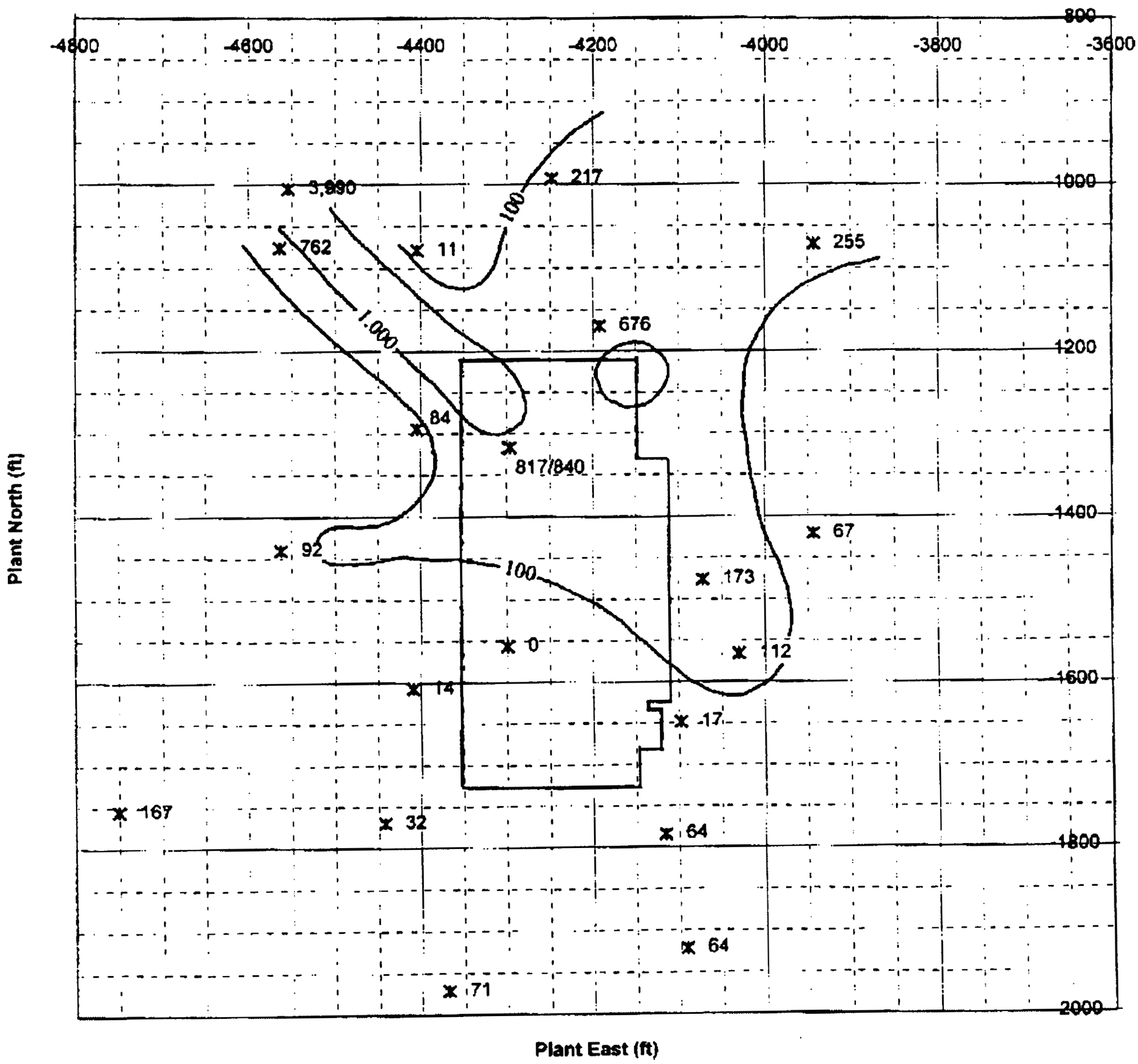
505146

TCE LEVEL (305.0 - 309.9)



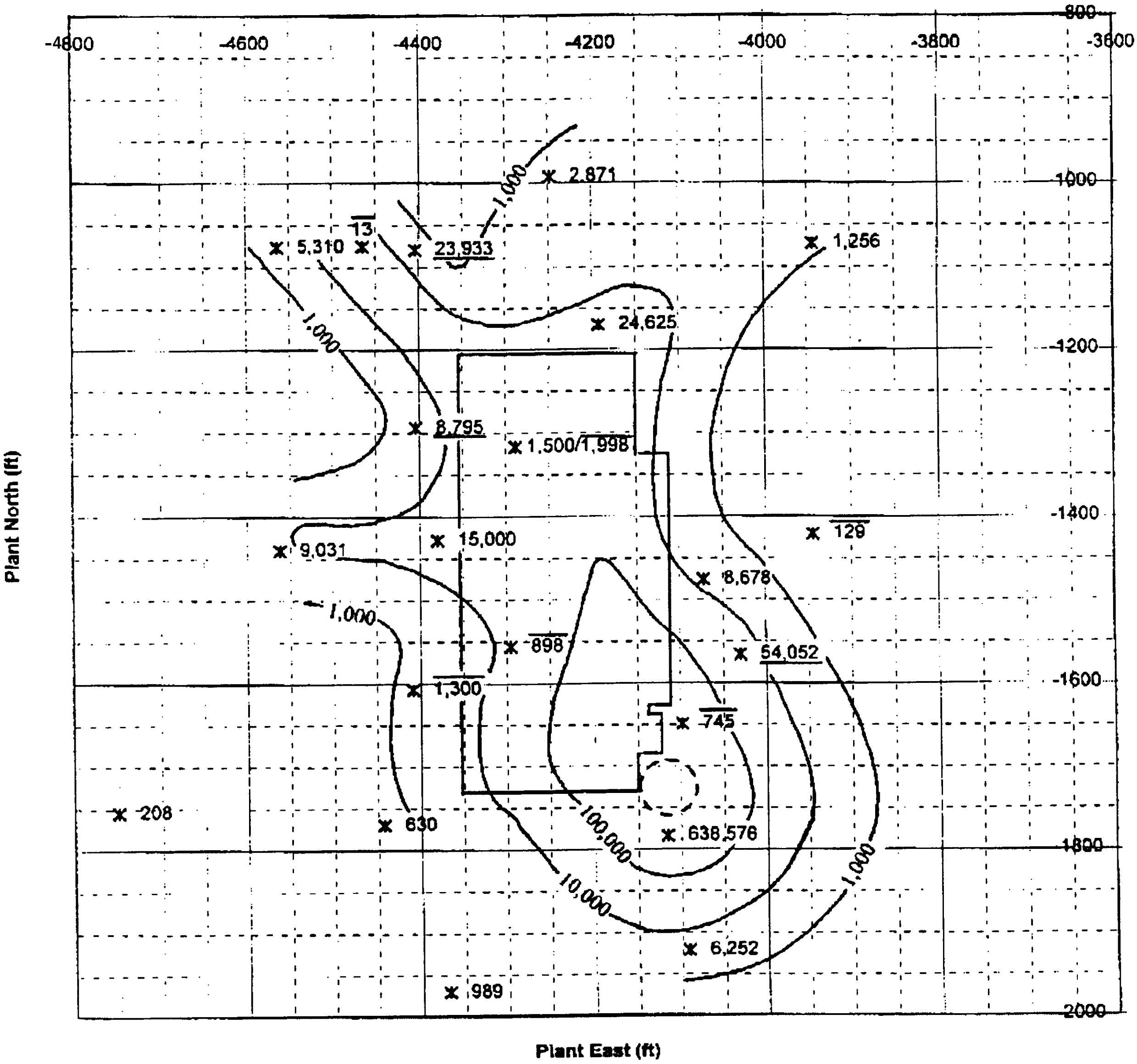
505147

BETA ACTIVITY (305 - 309.9 ft amsl)



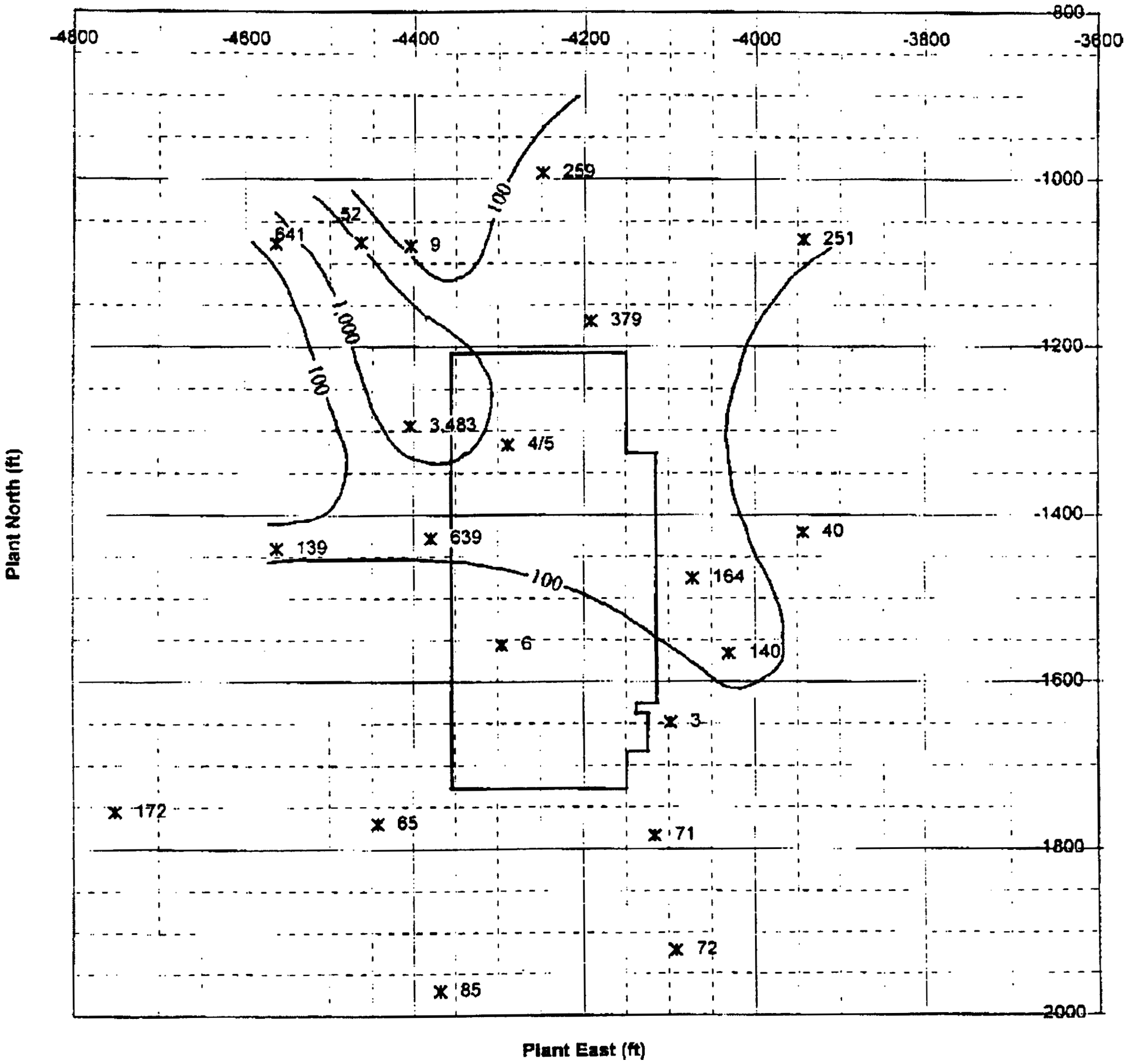
505148

TCE LEVEL *(300.0* - 304.9)



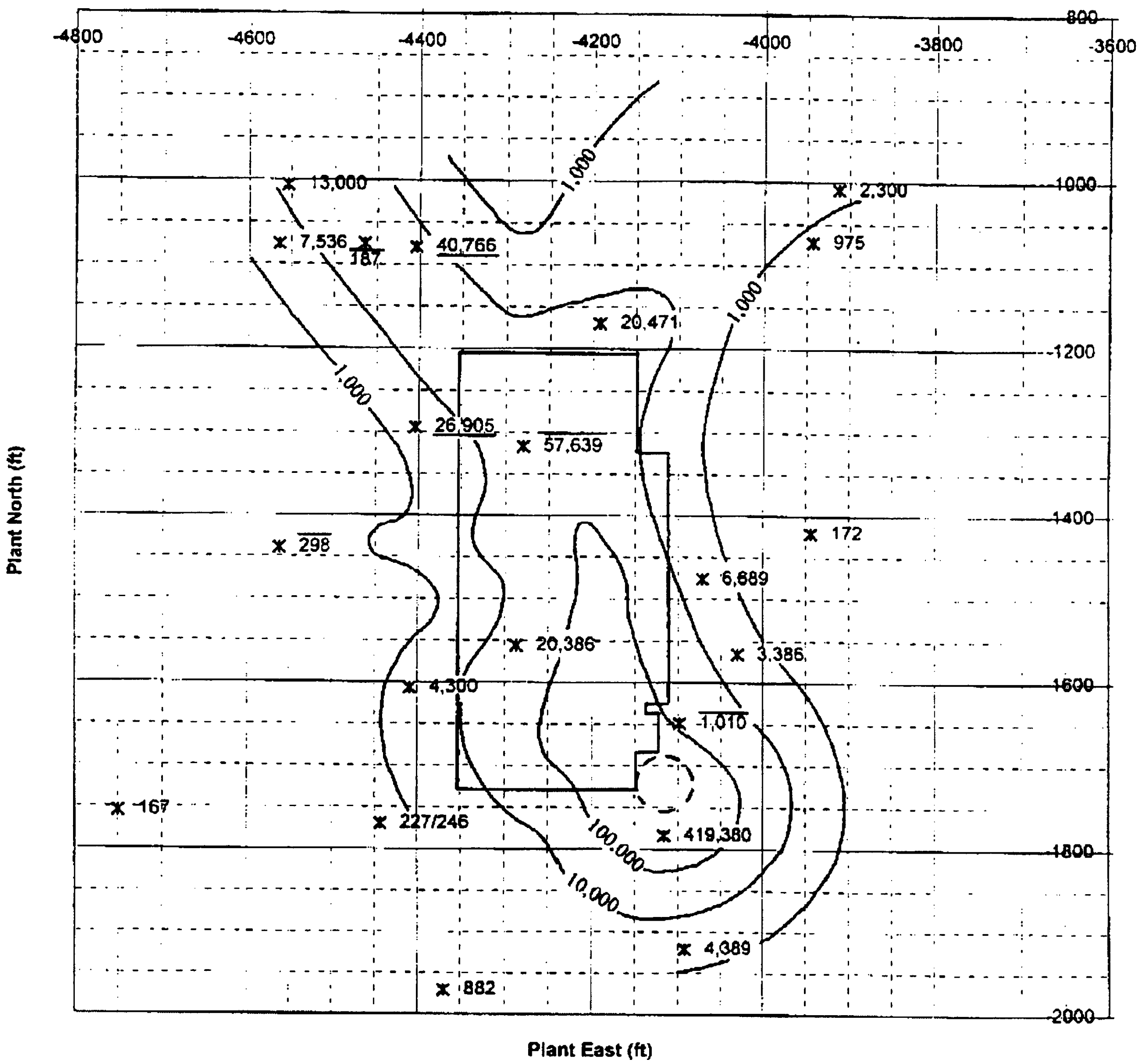
505149

BETA ACTIVITY (300-304.9 ft amsl)



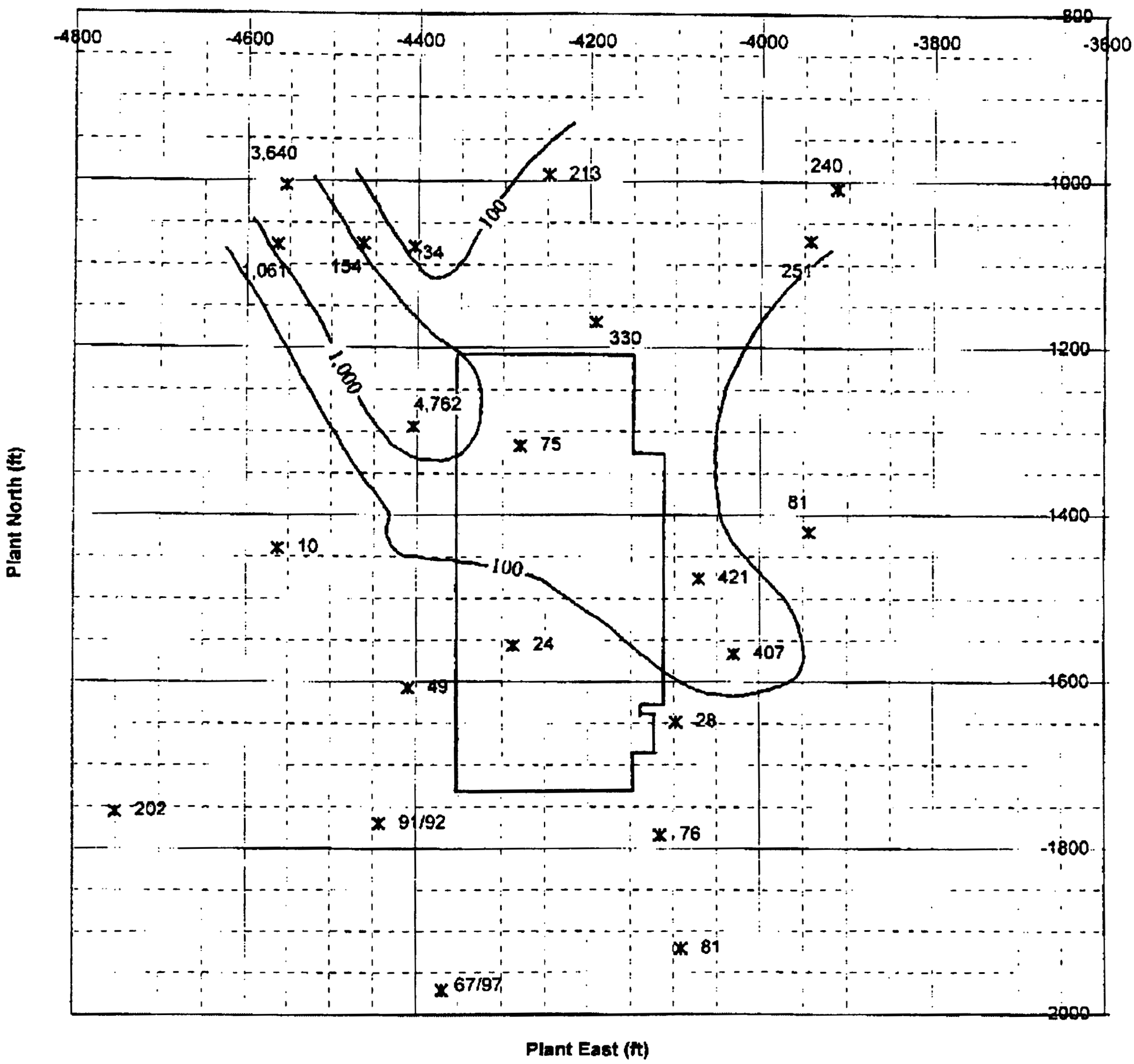
505150

TCE LEVEL (295.0 - 299.9)



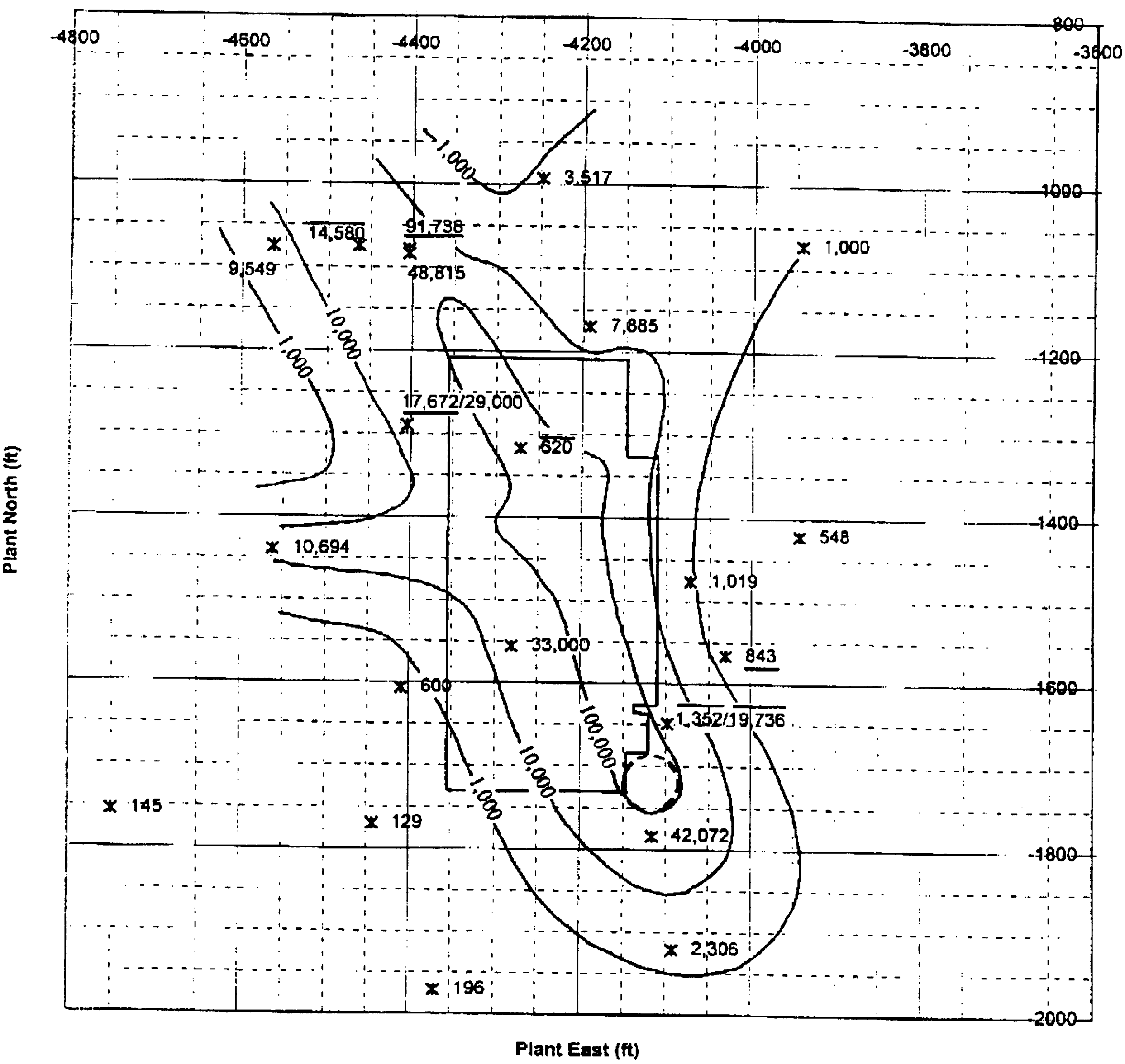
505151

BETA ACTIVITY (295 - 299.9 ft amsl)



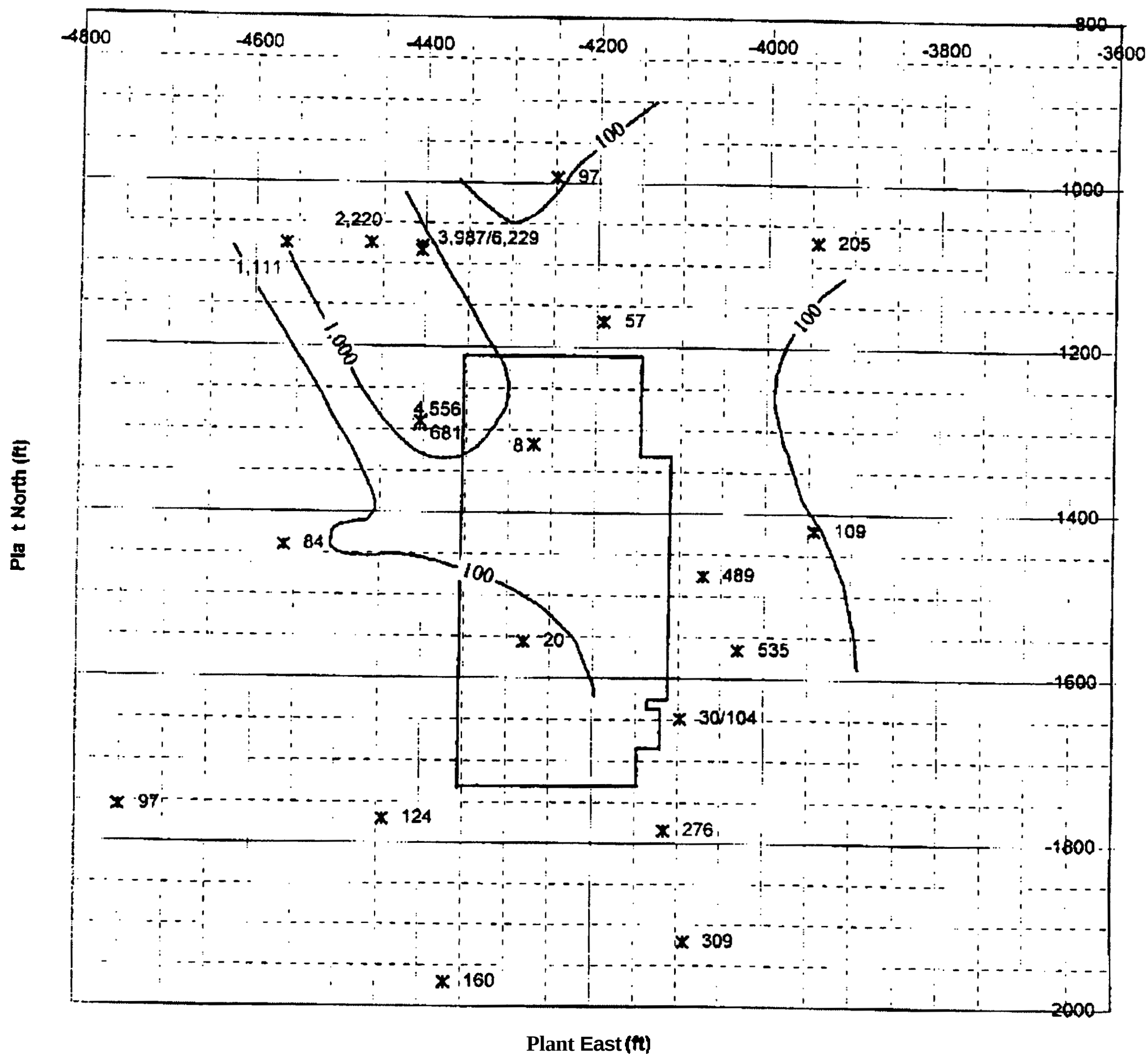
505152

TCE LEVEL (290.0 - 294.9)



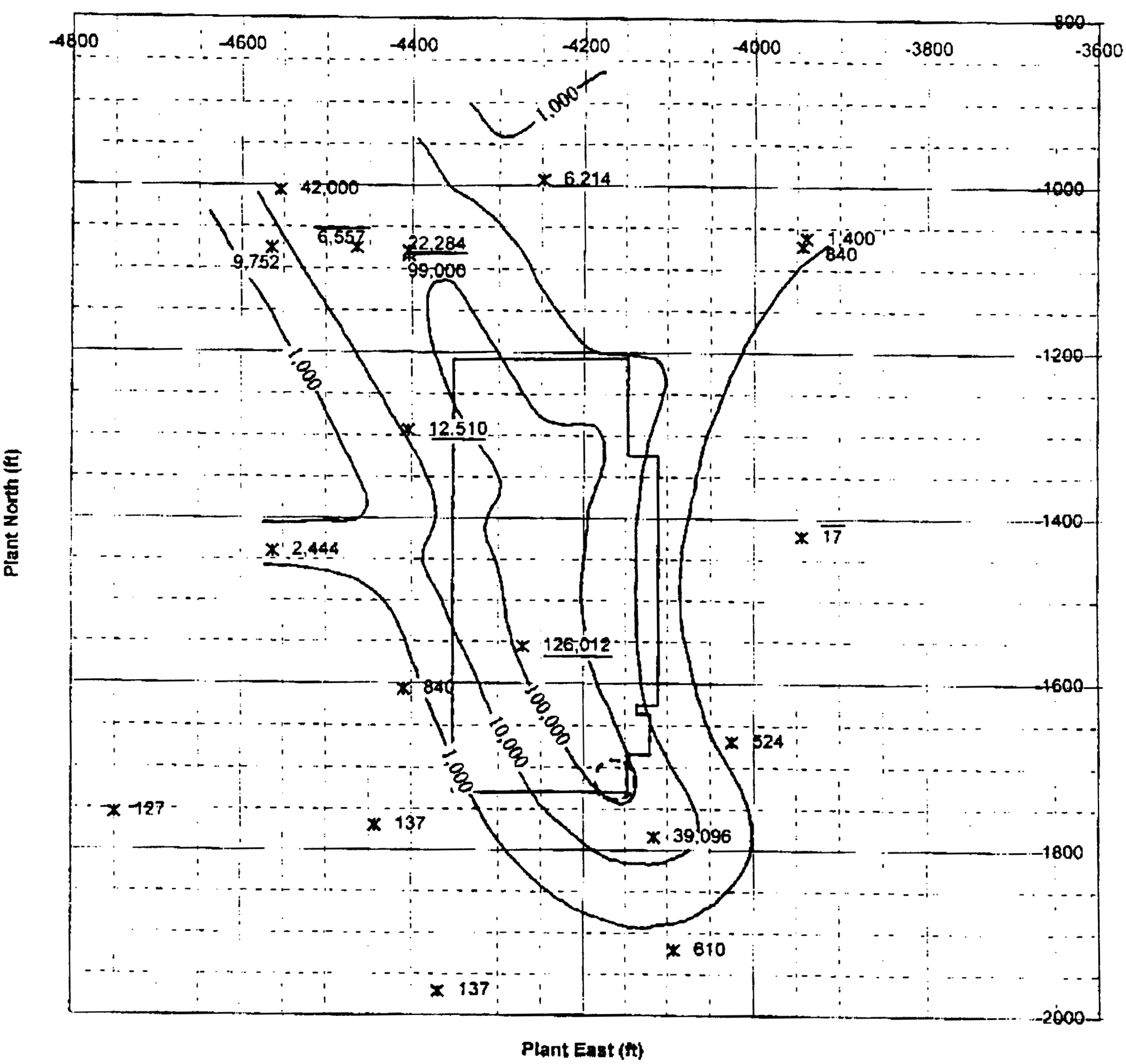
505153

BETA ACTIVITY (200 - 294.9 ft amsl)



505154

TCE LEVEL (285.0 - 289.9)



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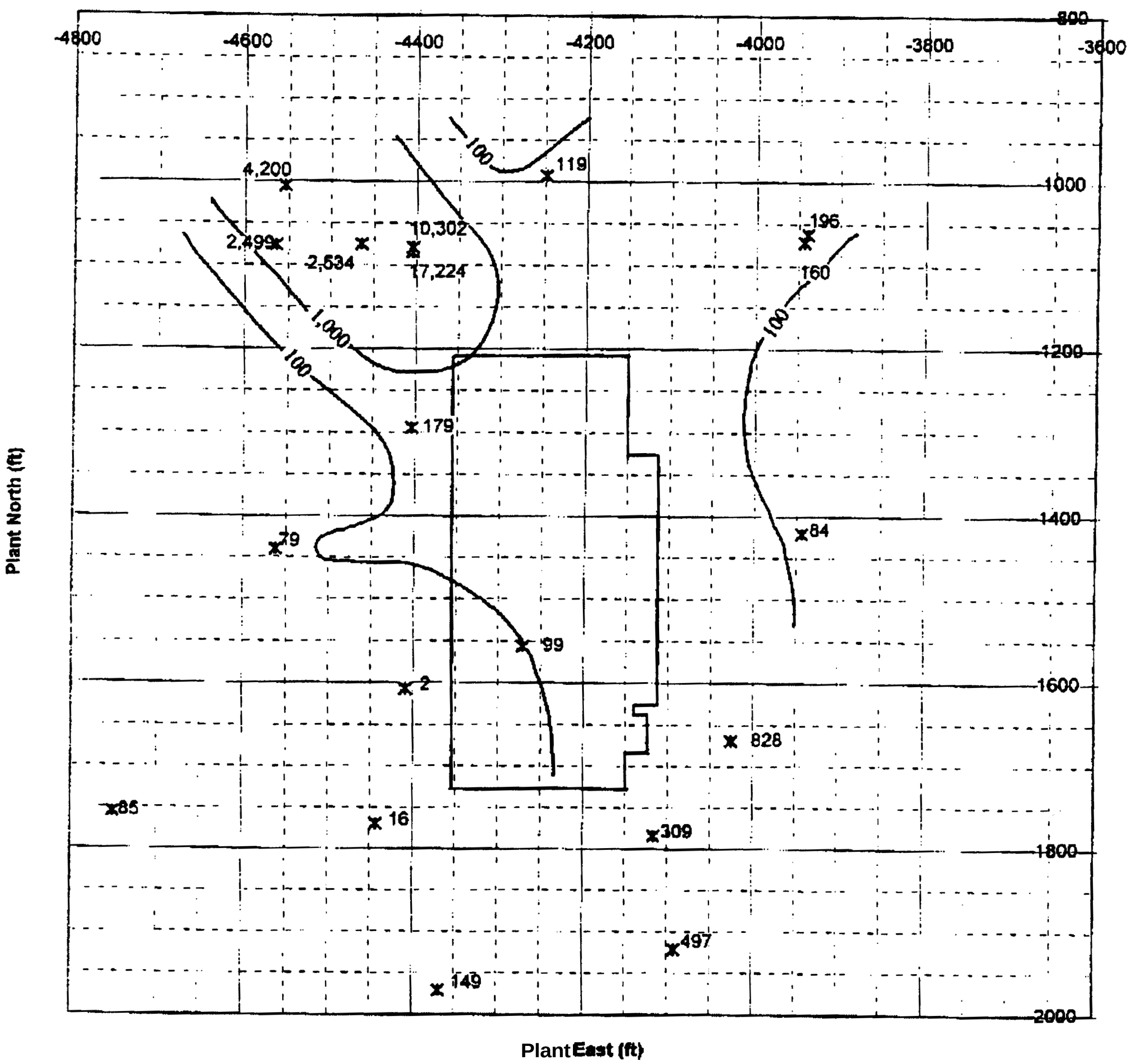
BETA ACTIVITY (285-289.9 ft amsl)



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